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THE
# ELECTRICAL REVIEW.

VOL. LXXXII. APRIL 12, 1918. No. 2,107.

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## NEW ENGINEERING INDUSTRIES.

THERE are so many committees engaged in considering some aspect or other of the operations of the industries in which readers of this journal are interested, that it is not unlikely that only a very few people in the electrical and engineering industries are able to keep themselves intelligently informed concerning even their existence and objects, much less their activities. We have no desire to institute a comparison respecting the importance and merits of our manifold committees; we can see good in them all, and recognise that, considered from some special standpoint, they are all important and have their place to fill in the great plans that the nation must be prepared to adopt in preparing for days to come. But while we may sympathise with all—though that need not be taken as saying that we express approval of the *personnel* of all—we recognise naturally enough that some of them are likely to be of direct and immediate benefit to the engineering and electrical industries if their work be well done. Now, we hold that no detached committee of individuals, even though they may each represent very large engineering companies or firms, can be qualified to advise with authority, unless they act in co-operation with the major part of the industries in whose interests they make their deliberations. Therefore, when we find one committee which has a very definite and practical duty laid upon it by the Ministry of Reconstruction, and that duty is one which may have great consequences for the engineering industries of the United Kingdom if the subject is wisely handled, we desire to urge the whole industry to regard this particular committee as one that stands apart from the general army of committees as being worthy of more than ordinary attention. We are referring to the Engineering Trades (New Industries) Committee, concerning which we gave some particulars in our issue of February 1st. We return to the matter now in case that mention of it may have been overlooked, and also because publicity among the industry itself is essential if the best results are to follow the Committee's endeavours.

The engineering operations in connection with the war have led to vast additions being made to works and to general manufacturing capacity, with the accompanying great increase in labour of all classes employed therein. When the war is finished and the Forces return to resume their former occupations, the new works will afford part of the accommodation required for employing the substitutional or additional labour which is now in possession. It is the principal function of this New Industries Committee to assist the engineering trade in dealing with this large problem of facilitating the establishment of new industries to occupy these works and this big volume of labour. The Committee desires to be informed by the trades generally, as well as by individual manufacturers, of all new projects for expansion of businesses after the war. This will serve two ends at least: it will make help as far as possible in securing supplies of materials; it may also be of use in securing that a number of concerns shall not separately concentrate their energies upon similar developments, so that after the war there is an unnecessarily large production of a particular class of article—possibly greatly in excess of actual or reasonably prospective requirements.

The members of the Committee are all connected with well-known engineering companies, and they

bring to their work considerable practical experience of the industries. They invite their fellow manufacturers to communicate with them, stating what are the difficulties that they anticipate meeting in their efforts to extend their industries after the war. It is conceivable that the collection of their views might be of considerable help to the Government in its efforts for enabling industry to overcome such difficulties. With political issues, such as protective tariffs, the Committee has nothing to do, but it is obvious that, whatever else happens, manufacturers will be encouraged to rely upon their own efforts and upon good organisation and efficient management. In this connection, specialisation in manufacture will almost certainly be encouraged, and it may also be accepted that manufactures which involve the employment of a relatively large amount of labour to the cost of production will be regarded both by the Committee and by the Government with special favour.

It has been frequently pointed out that the inevitable shortage of materials for engineering work in the period immediately following the war will require that such materials as are available shall be for a time under Government control. It is quite within reason to suppose that a priority for materials for new or extended industries of a character approved by the New Engineering Industries Committee may be granted to some extent on that Committee's recommendations. We would recommend those who desire to place their views before the Committee, or wish to make inquiries on any points that we have not covered, to communicate with the Secretary of the Engineering Trades (New Industries) Committee, at Armament Buildings, Whitehall Place, S.W. 1.

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**Railway Electrification.**

Many things have happened since the war began, to emphasise the importance of the question of converting our steam railways to electric traction—things of the most diverse character, but all, without exception, tending to the same conclusion. The limitations of our space forbid us to elaborate the subject, but we may profitably draw attention to a few of these concurrent factors, the pressure of which is constantly increasing in the aggregate.

First, of course, we may place the success which has invariably attended the adoption of electric traction on any important stretch of railway in this country, both before and during the war; secondly, but second only on account of distance, the corresponding successes which have been achieved abroad, especially by the great main-line undertakings in the United States, which have riveted the attention of the world's railway engineers upon this question; thirdly, the difficulty of handling suburban traffic at city termini, which has compelled the Great Eastern Railway, for example, by the mouth of Colonel Thornton, to admit the absolute *necessity* of electrification, even at the cost of excavating a huge underground station; fourthly, the shortage of coal, to which we refer later; and lastly, the coming reorganisation of electricity supply on the grand scale in this country.

Almost all of these points have cropped up separately at different times; on this occasion we wish particularly to direct attention to the last two items, which are, in fact, inseparable. According to Mr. E. W. Rice, President of the American I.E.E., whose address we quote elsewhere in this issue, if the American railways had been generally electrified, the coal famine from which the United States has lately suffered would have been largely, if not wholly, prevented, for the railways could have handled 50 per cent. more traffic, two-thirds of the coal consumed by the railways would have been saved, the decreased haulage of coal for this purpose would have set free another 10 per cent. of traffic capacity, and water-power could have been utilised. Every one of these arguments but the very last applies equally to this country. Further, when the railways are electrified, they will constitute one of the most important loads on the big power stations; this point must be borne in mind in locating the latter—and, still more important, the railways must be discouraged from putting down power stations of their own, on that individualistic plan which has so absurdly and unfortunately characterised not only some of our railways, but also, by a singular confusion of ideas, our municipal supply undertakings. Is it not extraordinary that the growth of socialistic, or, at least, communistic, ideas in the past century, which led to the municipalisation of electricity supply, also brought about the jealous isolation of each municipal undertaking from its neighbours? The parochial ideas from which we have suffered in the past must not be allowed to prevail in the future; we must all think co-operatively, and seek the welfare of the whole community rather than our own restricted ends, in the electrification of our railways as in other national affairs.

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**The I.E.E. and Foreign Trade.**

We have so often and so urgently pressed upon our readers the imperative necessity of organising ourselves, in order to develop our foreign trade directly our hands are freed by the cessation of hostilities, that we feel somewhat diffident in returning to the subject yet again. We have, however, at least two excellent reasons for doing so to-day, as we shall show. The occasion is the fact that an extra meeting of the Institution of Electrical Engineers is to be held next week (Thursday, April 18th) to hear and discuss a paper by Mr. Leonard Andrews, entitled "The Overseas Distribution of Engineering Appliances."

In the first place, the acceptance of a paper which deals wholly and solely with a subject which is essentially commercial, and the calling of a special meeting to discuss it, is an event which almost marks an epoch in the history of the Institution. We need not labour the point; during the war the Council has given many indications of broadening views, and we welcome its recognition, belated though it be, of the fact that its responsibilities relate not only to the technical affairs of the electrical industry, but also to the trade upon which that industry depends for its existence. The Institution of Civil Engineers led the way last year when it invited Mr. Edgar Crammond to address it on the subject of foreign trade, and we congratulate the I.E.E. on its coming into line with the senior Institution.

In the second place, while we must not infringe the ancient tradition, long ago swept away with other dusty relics of the past by our American comrades, that the contents of a forthcoming paper are strictly secret (except, of course, to those who apply for copies in advance!—where is our consistency?), we need not conceal the fact that we are aware of its contents, and, while we must defer comment and criticism for the moment, we may say that it is a remarkably bold conception, a gigantic scheme, which will afford abundance of material for a lively and entertaining discussion that will not be confined to the four walls of the theatre in Gt. George Street. Mr. Andrews is no mere theorist in this connection; he has gained experience of priceless value, and extending over many years, in the very field with which his paper deals, and we hardly need say that an enthusiast with expert knowledge of his subject is always interesting and instructive, whether we agree with him or not. We suggest, therefore, that next Thursday's meeting will be well worth attending, from every point of view.

## NATIONAL ELECTRICITY SUPPLY.

By A POWER STATION ENGINEER.

(*Concluded from page* 319.)

A difference in views exists in regard to the exercise of powers by a District Board in connection with (1) the construction of new power stations, (2) the responsibility for extending existing plants, and (3) the right to shut down an existing plant. The balance of opinion would, I think, favour the Board being entrusted with (1), although an alternative suggestion has been made that this work should not be carried out by a District Board, but by a small Joint Board consisting of two or more neighbouring authorities. Many undertakings look with alarm upon the proposals contained under (2) and (3), as these would seriously encroach upon existing rights. In effect, they say that if the National Scheme, with its large power stations, is justified, then the authority responsible for such a scheme must demonstrate by the low prices charged for bulk supplies that it will not pay either to extend or to run existing local plants. They are prepared to take part in any local interconnecting scheme so as to make better use of existing stand-by plants and to reduce the wastage of fuel due to light-load running; but will not agree to place in other hands the right to interfere with the internal management of the local power station. They further point out that some of the existing stations either contain economical modern plant or are capable of being remodelled at a comparatively low cost so as to produce much better results. It will, therefore, be possible, even under the existing conditions, to reduce the costs to a lower figure than can be obtained if a large portion of the existing capital is rendered unremunerative through the shutting-down of power stations, and additional capital charges brought into the cost sheet by purchasing from an outside source. In other words, the costs due to excessive capital expenditure on wholly or partially duplicated plant and transmission lines will be appreciably higher than any possible saving due to more economical generation on a larger scale.

There are, I think, two main points to bear in mind when considering the matter. The first is that efficiency cannot be obtained from a new station containing large units of plant unless an assured load is secured when the plant is ready for use. The second is that the maximum benefits cannot result from any scheme of co-operation amongst a number of undertakings if they retain the independent management of their local power stations, as each undertaking naturally considers its own interests first, irrespective of the effect on neighbouring authorities. A District Board owning and operating all the power stations will be better able to judge how any given area can be supplied under the most economical conditions than would those responsible for a single undertaking, as the spirit of rivalry or jealousy between one and another adjacent authorities, which is so often liable to influence decisions, will be entirely eliminated.

When an existing power station possessing economical modern plant is acquired by the District Board, it may be necessary to provide safeguards to ensure that the cost of the supply given subsequently by the Board shall not exceed the cost previously incurred. There are not, however, likely to be many cases of this kind, as all efficient plant will be utilised, and in certain instances extended, by the Board. It is the small and inefficient plant that must be shut down in the first place to provide the load for the new power stations. A considerable reduction in costs must result not only in capital expenditure, but in operating expenses, if extensions, which under present conditions are carried out by a number of undertakings, are pooled and provided on one site only. The new stations will be used in conjunction with existing efficient plants, the latter being run at or about full load during factory hours, say, between 6 a.m. and 5.30 p.m., Monday to Friday inclusive, and 6 a.m. and 12 noon on Saturday, leaving the new stations to deal with the combined light loads of a number of undertakings during the remaining hours of the week. Under these circumstances, the best possible use will be made of the existing capital expenditure on the plant, and, consequently, the savings effected, after allowing for transmission losses, will be more than sufficient to ensure that the prices paid by existing consumers will not be increased, but appreciably reduced.

Regarding the proposal put forward by certain parties that all the advantages claimed for ownership and operation by a District Board can be obtained by co-operation on an interconnected system, I am absolutely in agreement with the finding of the Coal Conservation Sub-Committee that interconnecting is only one small step in the direction of securing a cheap and adequate supply. Apart from its inadequacy, I consider that such a scheme, under separate ownership, is altogether unworkable in practice. To take an analogous case, imagine two separate manufacturing concerns, A and B, established adjacent to one another, both producing the same type of article. During one day, or week, or month A's output is seriously reduced owing to a breakdown, and B makes up the deficiency by using his equipment. A short time later the position is reversed, and A has to turn out the goods which B cannot produce. A little later still A has to execute more orders than he can deal with, and is not able at the time to extend his premises, but B is able to do so, and the goods are delivered. At a still later date there is a general shortage of orders both for A and B, and they decide that, instead of them both working half-time, A shall entirely shut down, and B shall work full time. Does any plain business man seriously think that, under such conditions, A and B are perpetually going to adjust the charges for services which one renders to the other, and continue to carry on under independent ownership and separate management? The one and only course for them to adopt is to amalgamate their interests, and continue as one undertaking. An exactly similar course will have to be adopted by authorities at present operating power stations if interconnecting is to be really effective.

Having outlined the different types of District Boards to whom the State might delegate the control of all existing power stations and main transmission lines, it will be useful to ascertain what interests are principally concerned in the efficient exercise of such powers. These will be:—(1) The State taking the part of the capitalist; (2) the authorised distributors as purchasers of the supply on the lowest possible terms; and (3) the large industrial consumers who depend on a cheap and adequate supply to maintain their commercial supremacy.

A District Board on which these three important interests are represented by men of ability may fairly be considered to possess those qualifications which will make it thoroughly efficient and reliable. In regard to numbers, a fair division would be one-third nominated or elected by each of the interests mentioned. The members nominated under (1) would be selected by the head of the Government Department concerned in electrical matters. Under (2) the representatives would be elected by each of the undertakings exercising distributing powers in the district, or, in the event of the number being inconveniently large, the undertakings would combine in groups for the purpose. The nomination under (3) would be made by Chambers of Commerce, manufacturing combines, employers' federations, and, in view of the Whitley Report, possibly also by engineering and allied Trade Unions. An alternative to the method suggested would be for all those representing particular interests to be specially selected and nominated by the Government Department.

In the event of all the power stations and main transmission lines in the country being acquired by the State, the sale of the undertakings belonging to local authorities will be facilitated by reason of the fact that the transfer will only be from a body of local ratepayers to a larger body of Imperial taxpayers. The responsibility for the capital expenditure will still rest upon the shoulders of the general public. The acquisition of the company undertakings may be more difficult, as the value of goodwill and future profits will influence the terms, particularly in those cases where the powers to operate have been granted in perpetuity and considerable sums have been spent in anticipation of future demands.

Assuming that the purchase is completed at or about a figure represented by the present capital commitments, it

will only be a transfer of capital and obligations incidental thereto from one set of proprietors to another. It does not involve the creation of fresh capital for the purpose.

## THE PROMULGATION OF IMPROVEMENTS IN DESIGN AND MANUFACTURE.

By "IMPRIMATUR."

Prior to the formation of trade associations, one of the chief features of competition between the individual firms engaged in an industry was the selling price. Competitors endeavoured to obtain orders on the basis of giving more for less money, an invidious rivalry which often led to the deterioration of the industry's productions—to the cheap and nasty form. In many cases, since improvements could only be adopted with an accompanying increase in selling price, manufacturers were restrained from improving a production beyond its accepted minimum marketable condition.

If an improvement was ever adopted, the maximum recompense was lost to the pioneer because of the accepted principle that it was necessary to conceal the improvement as much as possible from rivals, with the outcome that a considerable time elapsed before the improvement percolated to likely customers. Meanwhile, if a competitor was determined to produce an imitation, there was plenty of time for that object to be accomplished, and then it was difficult to decide to whom the credit for the original idea was due; the imitator could indignantly dispute priority, and secure orders to the detriment of the originator. So long as this illogical policy of secrecy was upheld, there was not much incentive to progress in design, even when it did not signify an increase in selling price.

The establishment of industrial or trade associations pledged to adopt a common policy has practically abolished price rivalry, with resultant benefit to both buyer and manufacturer. The tendency is to raise the quality of the industry's products, and although the selling price may be increased, the quality is increased to a greater degree.

But having subdued an unwholesome form of competition by means of co-operation through industrial associations, it would be unfortunate if co-operation in industries should be the cause of the cessation of competition in other directions. The natural corollary would be a combine, with the consequent deterioration of the industry's products from that high standard which healthy and legitimate competition produces.

Individualistic competition must be continued if the productions of an industry are to be kept continually on the up-grade in efficiency of design and manufacture.

With the introduction of trade associations, the buyer has the choice from half a dozen productions, each guaranteed under the same conditions and sold at very much the same price. How, then, is a preferential purchase to be made? If the articles are produced to operate under standard conditions, the materials used in their manufacture will be more or less of the same quality, so that the chief considerations will resolve into the particular manner in which the materials are adapted to form the product and the processes the materials go through in the factory—in other words, development of design and methods of manufacture. The publicity policy of individual manufacturing organisations must, therefore, be based principally on these features, so that probable buyers will be informed of the superior details of design, and of the modern and efficient methods by which the design is manufactured.

This policy necessarily includes the immediate announcement and utmost publicity of improvements if the maximum reward is to be obtained for their introduction. Trade associations have removed the cause, if any existed, for the policy of secrecy, and if doubt still remains it is based on a fallacy. Before competitors can incorporate the improvement in some other guise into their productions, the original producer will have reaped the benefit by the promulgation of the improvement immediately it is ready for the market.

Organised publicity methods will inform the buying public of the original development, and to whom it is due, and palpable imitations which follow will be recognised. The disciples of imitation will be discredited by never being up-to-date, whilst the manufacturer, who creates improvements and immediately publishes them, will build up a valuable commercial asset in the reputation for producing articles of improved design in advance of competitors. It follows, then, that the special features which distinguish the designs of similar productions of the several firms in an industry enter largely into the selling element.

New methods of manufacture must also be given greater publicity to inform the buying public of the characteristic methods of manufacturing a particular product, and thus provide evidence of its reliability and proof that it is the result of the best practice of that particular industry. If competitors adopt a similar practice, it will only be after a lapse of time necessary to adapt the factory to the change, and, meanwhile, the originator has had ample time to obtain a return for his ingenuity if the information has been distributed by suitable publicity. By adopting a policy of publicity relating to design and manufacture, the buying public will identify a production by the characteristic features of the design, and by the methods of manufacture peculiar to that design.

The market for an industry's productions is divided into sections; to one section one particular production will appeal, to some other section another. These sections owe their origin, not to the manufacturer, but to the buyer. A manufacturer creates a market when he offers to the public a production which hitherto has not been used, and induces the public to buy it; but when competitors appear producing similar articles, it is the buyers, now with a variety of designs from which to choose, who form the sectional markets for each similar production. According to John Stuart Mill, the reasons which should govern the making of a choice depend upon the exercise of "the human faculties of perception, judgment, discriminative feeling, mental activity, and even moral preference." Under the co-operative conditions fostered by trade associations, an industry's productions do not demand the exercise of all these faculties, so that moral or instinctive preference will probably be a chief faculty exercised in making a selection.

It is the object of a manufacturer's publicity organisation to attract buyers from one section of a market into that section which favours his productions. This competition tends to perfection of design, as it gives a stimulus to each manufacturer in an industry to employ the best skill both for designing the production and for devising methods of manufacture, and the improvements provide the subject matter for original publicity methods to make them manifest. For general engineering purposes that publicity should be cultivated which will incite the mental activity of buyers, influence their discriminative feeling, and persuade them to doubt the moral preference they may have for some other production; and it must be persistent. Kindle the fire of doubt and persistent publicity will fan the flame!

Collective publicity is another form of co-operation which industries are being urged to adopt. There is undoubtedly a field for co-operative publicity, but it is limited to the circumstances where an industrial association, acting as an individual, adopts a general form of publicity to be absorbed by the public, *en masse*, as an individual. Under these conditions, a trade association is in the same circumstances as an individual manufacturer, and has as competitors other similar associations. If the association includes the whole industry of a country, then it is the like industries of other countries which are the competitors, and the nations are the individual buyers. Price will then be the chief feature of competition, and the inference is that international federations of industrial associations will eventually develop, and international industrial associations offer a firm foundation on which a practical "League of Nations" could be built up.

Under the accepted competitive conditions, however, the adoption of collective publicity would be advisable as an introductory measure to create foreign markets for the purpose of increasing the export trade of an industry. But to secure and hold a section of buyers for individual productions, each manufacturer must organise appropriate publicity applicable to his distinctive productions.

Collective publicity of a trade association in the country

in which the industry is situated is of doubtful utility considering the cost, other than when it is organised to counterblast the efforts of a foreign invader, and even then it is an open question if suitably-organised individual publicity would not be more effective. Collective publicity is only efficient when the productions which form the subject of the campaign have no distinguishing features one from the other.

Individual publicity is an absolute necessity wherewith to induce buyers into the sectional markets favourable to individual designs, and this publicity will obviously have more effect when issued "straight from the stable" than when it forms but an item of the co-operative publicity-punter's "selections."

The proposed scheme for the reorganisation of electricity supply undertakings into a small number of large central stations, if carried out, will not lessen the need for organised publicity in this direction. In fact, to obtain satisfactory results from such a scheme, effective concentrated publicity will be necessary; but a co-operative publicity campaign does not present convincing indications of success. Such a campaign would suffer from the inherent restrictions indicated above, although there can hardly be any claim to characteristic designs in electricity. But there are characteristics peculiar to districts which would have the same effect. As an example, the publicity propaganda suitable for Birmingham could not be effectively applied to Glasgow. The housing conditions differ materially, to say nothing of the difference in temperament of those who live in the houses. The organisation of an "electricity supply" publicity campaign would require to adapt the methods of publicity to the peculiarities of the district and its inhabitants, consequently the publicity matter could be arranged more effectively on the spot where facilities are at hand for acquiring data on local conditions, so that each electricity supply centre would obtain much more substantial and competent service from its own publicity organisation than from any collective publicity campaign.

The organisation of *simultaneous* publicity campaigns offers many advantages, with much greater prospects of success than collective publicity. A Committee of the industrial association or supply centres could prepare a programme of subjects to which it was desirable to give wide-spread publicity, with dates arranged and agreed upon to be devoted exclusively to each item. With the programme as a guide, each individual publicity department would arrange matter and advertisements, which would be identical in topic, although distinctive in treatment, and by adhering to the precepts of the programme, advertisements and amplifying publicity matter would appear simultaneously, each successive issue being devoted to a particular item of interest. If overlapping should occur, it would be more of a desideratum than a drawback; the display of individual methods employed in approaching similar subjects would divert the reader and arouse greater interest. Let publicity work be overlapped if it may not be overlooked.

With collective publicity the tendency is to adopt large intermittent advertisements, whereas with simultaneous publicity there would be a variety of medium-sized advertisements. Research into the psychology of advertisements has proved that the persistent repetition of a portion-of-a-page advertisement is much more effective than an intermittent full-page advertisement.

Again, as previously explained, the lucubrations of collective publicity would not provide the necessary information to enable intending customers to choose which manufacturer's production was preferable, whereas simultaneous individual publicity would offer at the outset a collection on which the probable buyer's selective faculties could be exercised to make an initial choice. Thus by simultaneous publicity the object of collective publicity would be achieved, whilst individual publicity, with its discriminative attributes, would be utilised.

**Magneto Manufacture in Sweden.**—The Priorverken Aktiebolag, of Nörrköping, Sweden, has recently commenced the manufacture of magnetos and sparking plugs for ignition purposes on petrol motor vehicles.

## WRECK OF A 35,000-KW. TURBINE.*

A 35,000-KW., 20-stage, 1,500-R.P.M., 25-cycle horizontal single-cylinder impulse steam turbine in the O Street Station of the Boston Elevated Railway Co. was completely disabled and seriously damaged while in service on February 14th, 1918. There were no casualties, and no one was injured. A distorted cast-iron diaphragm in the 18th stage presumably fouled the 18th wheel, breaking off the buckets, after which the buckets and diaphragms from the 18th stage on to the last, or 20th, wheel, also the entire casing, were destroyed. A turbine of a type similar to that which was wrecked is shown in figs. 1 and 2.

To get a proper perspective of this accident one should go back a year ago, when, on February 14th, 1917, the 18th diaphragm became distorted; that is, it deflected at its edge

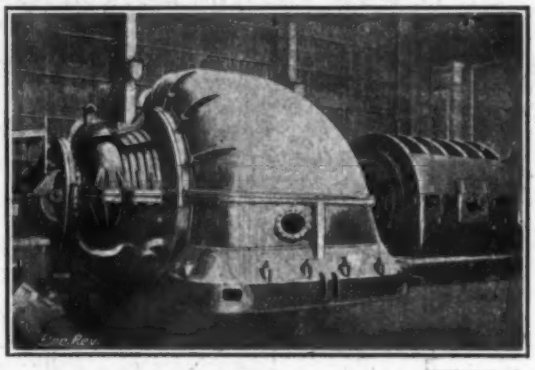

FIG. 1.—CASING OF TURBINE OF TYPE SIMILAR TO THAT DAMAGED IN BOSTON.

in the direction of the 18th wheel, rubbed the buckets where they join the wheel, and stripped the buckets from the 18th and 19th wheels, seriously damaging the 18th and 19th diaphragms. This happened when the machine was being given trial runs. Rubbing began and the throttle was tripped, after which the damage to the buckets and diaphragms followed. When the buckets let go, the speed was below the normal 1,500; perhaps 1,000 or 1,200 R.P.M.—no one knows.

After the accident of February 14th, 1917, the capacity was reduced to 20,000 KW. from March 17th to May 23rd, while repair parts were being made, by locking closed the secondary valve, which admits steam to the 7th stage. The repair parts in place and the machine in service, annoyance was given because the machine would not carry the load with its swings of 2,500 KW. above the rated 35,000 KW. under the operating conditions. When these swings came, the cycles dropped from the normal 25 to 24. The purchaser was most anxious that the turbine should carry the swings, and it was suggested that 19 1¼-in. holes be drilled in the 8th diaphragm in front of

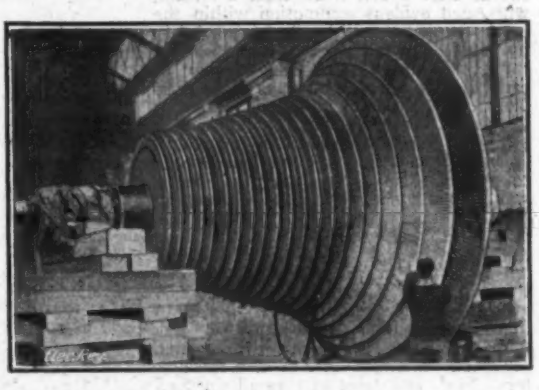

FIG. 2.—ROTOR OF THE TURBINE, THE CASING OF WHICH IS SHOWN IN FIG. 1.

the 8th wheel (see figs. 3 and 4). The holes were drilled to admit high-pressure steam to that stage. The turbine then carried these swings.

The machine was designed for 200 lb. gauge pressure at the turbine throttle, 200 deg. F. superheat, and 29 in. vacuum at 30 in. barometer. There was a pressure drop of 4 lb. in the steam line between the boilers and the throttle, or from 200 lb. to 196 lb.; the drop through the governor valves was also slightly more than normal. The builder states that on August 15th last, with 188.7 lb. gauge pressure at the throttle, 132 deg. F. superheat, and 28.7 in. vacuum, the turbine car-

* *Power*. Vol. 47, No. 12. Abstract.

ried 36,500 KW., and that, based on these figures, the capacity would be 39,000 KW. under contract conditions.

Rumour has had it that thrust-bearing trouble was responsible for the accident of February 14th, 1918. The most authoritative statement claims that what little thrust-bearing trouble did arise did not present itself until after 1917. The trouble was not inherent in the bearing, but was due to oil of poor quality, it having been used for too long a time. After this incident new oil was put in, and the bearing burned out a week later, caused most likely by interference with the oil circulation. Slight changes were made to the circulating system, and the machine was put in service on January 26th, 1918, after which no further trouble was experienced with the bearing. So, evidently the bearing had no influence whatever on the present accident.

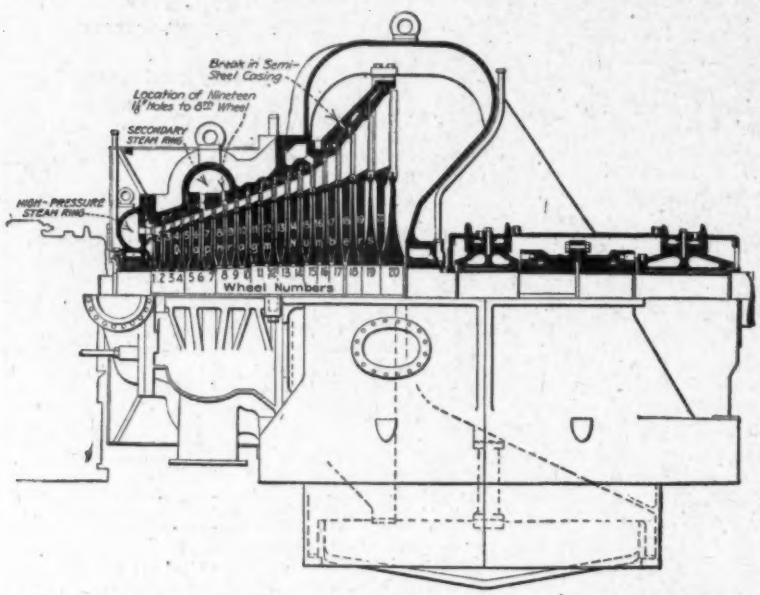
Break in Semi-Steel Casing
Location of Nineteen 1¼" Holes to 6th Wheel
SECONDARY STEAM RING
HIGH-PRESSURE STEAM RING
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20
Wheel Numbers

FIG. 3.—LONGITUDINAL SECTION OF 35,000-KW. TURBINE DAMAGED IN BOSTON.

With the foregoing in mind, let us take up the details of the accident. On February 14th, 1918, at 4.55 p.m., when the evening peak load was mounting, the machine was heard to rub, and observed to vibrate. Members of the operating crew climbed on top of the platform to adjust the thrust bearing, hoping to stop the rubbing and consequent vibration. The statements of these men say that the first vibration was heavy, that it was of the nature of a shock, after which there came a second, with such evident commotion within the casing as to cause all hands to seek safety by running to cover.

Six minutes after the first sign of serious rubbing, the damage was completed, and pieces of metal had ceased to fly about. The period during which pieces of the turbine were flying about, and while the low-pressure end of the rotor and casing were going to pieces, was probably not more than 30 seconds.

Going back to the time that the first severe rubbing was heard, at this time the central station of the same company, which is tied in with the O Street station, dropped its load of about 10,000 KW. owing to a station blow-out. Prior to this the machine now damaged was carrying 32,000 KW. This turbine was practically the only unit to take the system's load, and tried to take all the load dropped when the blow-out occurred, by opening wide its secondary valve. The quick opening of this valve so suddenly increased the steam pressure in the low-pressure stages that the impact was probably sufficient either to distort the 18th diaphragm initially and seriously or further to distort it if already deflected, sufficiently to make it further foul the 18th wheel.

When the secondary valve opened, the machine was said to take on 37,000 KW. Whether it took but 37,000 or, because of the momentum of the rotor, took every kilowatt of that 10,000, no one knows, for it seems there was no instrument to record the load it did take. But it appears certain that the machine took a very heavy load, and took it with the suddenness of a hammer blow. The cycles had dropped from the normal 25 to 24 when the switchboard operator noticed that the turbine was carrying 37,000 KW. Unable to stop the rubbing, the operator on the floor signalled the switchboard man to take off some load, which he did, dropping it to 32,000 KW. It was soon after this that the turbine went to pieces. The buckets on the 18th wheel ripped off, and fouled the 19th diaphragm, which in turn fouled the 19th wheel and the 20th diaphragm.

It is interesting to note that the buckets from the 18th wheel were broken identically as were the buckets from this wheel in the accident of a year ago. In the recent accident the same evidence of heating of the buckets where they join the wheel is apparent as was apparent on the buckets damaged a year ago. Fig. 5 shows where the buckets rubbed, and how they left the wheel. These buckets are indeed tough, as shown in fig. 7. The 20th, and last, wheel has all or nearly all its buckets, though they are severely bent and twisted.

Reference to figs. 3 and 6 shows that a break occurred in the semi-steel frame which holds the diaphragms in the low-pressure end. This conical frame dropped into the condenser, crushing the tubes for a depth of about 2 ft. When this frame broke, it is probable that the 19th and 20th diaphragms let down on the shaft, or, more correctly, on the wheel bases, and either revolved with the shaft, then broke due to centrifugal force, or they were broken at the time their supporting frame cracked by reason of being struck by fragments from other stages. These diaphragms were of cast iron; centrifugal force may have broken them, but at any rate they were broken in many pieces, and were hurled against the outside casing with force enough to blow out the whole end of this casing and break the great web, or bracket, that supports the bearings on the generator side of the turbine. The significant fact is that these diaphragms were the only large pieces of metal to break up completely and leave the turbine.

There are some interesting speculations as to what broke the conical semi-steel casing which held the low-pressure diaphragms, and which enclosed the last five wheels. The designer of the turbine shows by calculations that high-pressure steam at that point, caused by possible closure of the buckets in the 19th diaphragm, could not do it, as the pressure in the ledges A, B, and C, fig. 6, probably was not more than 186 lb. at most. He thinks that the expansion of the 18th diaphragm, caused by the diaphragm rubbing the buckets on the 18th wheel, may have forced the ring D, which is the outside or ring of the 18th diaphragm, to exert pressure enough on the casing to fracture the latter. Others think that it was broken by pieces of diaphragm being jammed against it.

The whole turbine casing is ruined, being severely cracked at the low-pressure end, with other smaller cracks extending to the high-pressure end. As stated, the great bracket, or web, supporting the bearings between the turbine and generator dropped away, letting the bearings free. The low-pressure labyrinth packing was destroyed. There was thrust enough to break the collars at the bearings and to push the

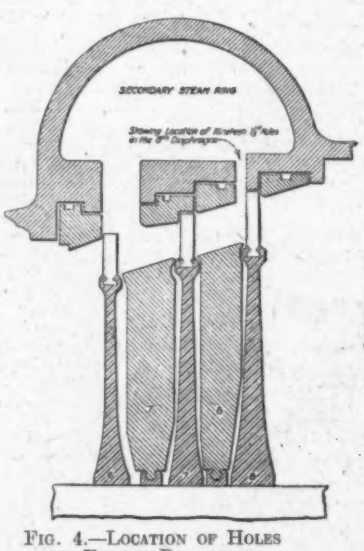


FIG. 4.—LOCATION OF HOLES IN EIGHTH DIAPHRAGM.

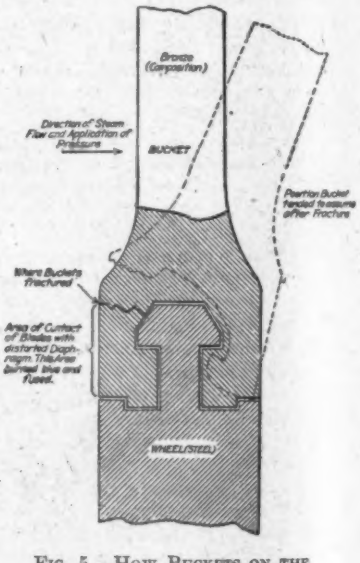
Bronze (Composition)
Direction of Steam Flow and Application of Pressure
BUCKET
Portion Bucket Bended to assume after Fracture
Where Buckets Fractured
Area of Contact of Blades with distorted Diaphragm. This Area Burned blue and Fused.
WHEEL (STEEL)

FIG. 5.—HOW BUCKETS ON THE EIGHTH WHEEL WERE BROKEN.

exciter, mounted on the end of the mainshaft, forward sufficiently to break the four spider brackets supporting the extreme end of the exciter shaft. The collars on the thrust bearing at the high-pressure end are intact.

All wheels and diaphragms up to and including the 17th stage are intact. The 18th, 19th, and 20th wheels are intact, though their blading is either gone or ruined. There is one small piece out of the rim of the 20th wheel, broken out, presumably, by being struck a tremendous blow by a fragment of diaphragm. Fortunately, the automatic throttle valve which controls steam to the turbine tripped; the men do not remember tripping it, and probably vibration did so, as valves of this design are held open by a catch resting on a steel knife-edge.

That the turbine wheels, especially the 20th, are intact is most gratifying. Nothing could more thoroughly prove the correctness of the designer's calculations and more completely convince one of the adequacy of the factor of safety

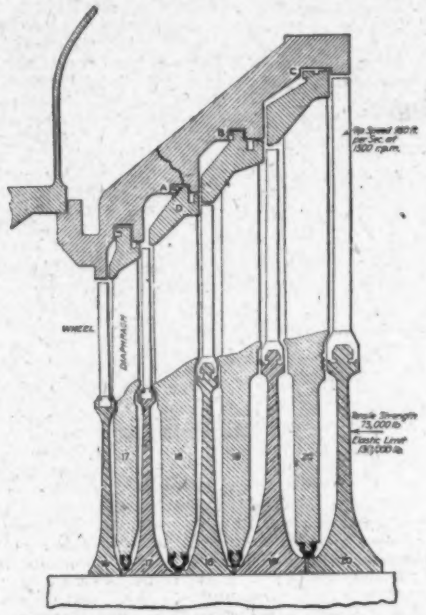

Fig. 6.—Section of Last Wheels and Diaphragms, together with Diaphragm Support Frame, which Broke as Shown.

of these wheels. The 20th wheel has a tensile strength of 13,000 lb., and an elastic limit of 73,000 lb. per sq. in. It is 12 ft. 1 in. diameter, and its tip speed at 1,500 r.p.m. is 950 ft. per second.

The Boston wheel was certainly subjected to jamming and impact from broken blading and pieces released from diaphragms, and it witnstood these severe shocks while subjected to the centrifugal force due to rotation at the normal speed. The machine was carrying 29 in. vacuum at the time the low-pressure end of the casing was blown out. Just what effect the sudden release of the vacuum had one can study out at leisure.

It is probable that steel will be used in the last stages of the Boston turbine when it is repaired. When the machine

Fig. 7.—Buckets as found after the Accident.

gets its new casing, the great web supporting the bearings at the generator end will be of steel for the sake of greater safety than cast-iron ensures.

The turbine with its condenser represented an investment of about 335,000 dols.

The details of the accident described, some general observations are in order. It is obvious that cast-iron should not be used where it is likely to be subjected to the stresses imposed by the centrifugal force that a steam-turbine diaphragm would be called upon to resist if it revolved with the shaft. If there are no probabilities of these large diaphragms being let down on the shaft, and if it is found that cast iron for these relatively thin disks is not subject to too great deflection, cast iron seems suitable, as the diaphragms now in use have a high factor of safety against rupture by normal stage pressure.

Since these high-capacity turbines, with their rotations which give wheel-tip speeds of nearly 1,000 ft. per second, have appeared, all have learned that rubbing of a diaphragm on its adjacent wheel and *vice versa* must be immediately stopped to avoid the loss of blading or more serious trouble. The element of time is most vital. In the Boston case, if the throttle had been tripped at the first sign of serious rubbing or vibration, it is probable that the turbine would have needed nothing more than new buckets for the 18th wheel—a delay, of course, but not a delay plus a direct loss of, say, $200,000.

## CORRESPONDENCE.

*Letters received by us after* 5 P.M. ON TUESDAY *cannot appear until the following week. Correspondents should forward their communications at the earliest possible moment. No letter can be published unless we have the writer's name and address in our possession.*

### The E.P.E.A. and the C.T.A.A.

With reference to Mr. Thomson's letter in your issue of March 29th. I regret, as the individual responsible for the report of the meeting of the Council of the E.P.E.A., that my use of the term "application for affiliation" should have caused any dissension.

The following is an excerpt from a letter received some time ago by Mr. W. A. Jones, hon. secretary to the E.P.E.A.:—

"My Association has expressed the desire that their Executive Committee should meet your Committee at an early date, with a view to discussing the question of affiliation.

(Signed) A. P. Macalister.
"*Hon. Sec. C.T.A.A.*"

A meeting of the respective Committees was held, and it was decided to refer the matter to the Council of the E.P.E.A. Unfortunately the C.T.A.A. found it impossible to send representatives on the date fixed for this meeting. It was hoped that the report of the discussion and the resolution would have cleared away any doubts and uncertainties, and emphasised the necessity for more cohesion and the inadvisability of raising up barriers of isolation between grades where now, in our Association, no such barriers exist.

Some time ago, in face of the onslaught of the powerful organisation of the rank and file, the E.P.E.A. marshalled the staff engineers of electricity supply undertakings, and received the active support of some chief technical assistants. There were inquiries from others, and, with a view to finding some common basis to incorporate all grades of staff engineers, a meeting of the higher officials, arranged by our Reconstruction Committee, was held at Hammersmith. It was there decided to form a new Association, and a Committee fully representative of all grades of staff engineers from company and municipal undertakings was elected.

The hon. sec., Mr. H. W. Healy, several times summoned the members to meetings, but on each occasion was informed by the C.T.A.A. that their representatives would not attend until such time as the Conference of Company Chiefs and the Associated Municipal Electrical Engineers had decided to send representatives. Efforts were made to this end, but the process was slow, and the Committee appointed at Hammersmith has never yet met. Impeded thus for some time, the Reconstruction Committee of the E.P.E.A. found enthusiasm waning, new Associations springing up in the provinces, and then decided to develop their existing Association on the broad lines of catering for all grades of staff engineers. A national conference was held, the new Associations were amalgamated, and the country was divided into three sections, with centres at London, Birmingham and Manchester. We have at the present time nearly 1,000 members, from chief engineers to junior engineers.

We are keenly desirous of getting the advantage of the support of our London colleagues of the C.T.A.A., but the opinion of the provincial centres and our London Council is that the present system of including all grades of qualified engineers in the membership of the E.P.E.A. is a triumph for the homogeneous, and any step in the direction of the heterogeneous is retrograde, weakening, and undesirable.

The possibility of separating so-called seniors and juniors is beset with difficulties. The position of engineer-in-charge is not now, as in the long ago, a stepping-stone, but a career, and it is incongruous to style our present-day "engineer-in-charge" a junior.

We trust we will hear no more the claims for grade-distinctive societies linked with thin ties of affiliation, but that the best efforts of the existing associations will be bent away from rivalry and towards amalgamating forces with the object, commendable to both and essential to the future well-being of our industry and our country, to improve the efficiency and status of the engineer engaged in electricity supply.

**George C. Law.**

Electricity Works, Mortlake, *April 2nd*, 1918.

**Concert.**—The London Station Engineers' Branch of the Electrical Trades Union is holding its first concert at the Horns Hotel, Kennington Park, S.E., on Wednesday, April 24th, at 6.30 p.m.

## POPLAR COMMUNAL KITCHEN.

We recently had the pleasure of inspecting the National Kitchen which has been installed at the Bow Baths of the Borough of Poplar by the Borough Council, and which was opened by Lord Rhondda, on March 26th. The kitchen has been in operation for about a month, and is open from 11.30 a.m. to 1.45 p.m., and from 5 to 8 p.m.; over 2,000 portions are served daily, and the public appreciation of its advantages has been manifested by its rapid growth in popularity. Seating accommodation is provided for some 250 persons in a light and airy hall fitted with tables, and nearly 500 persons take their meals on the premises, in two shifts; others bring dishes and take the food home. The tariff is extraordinarily low, the charge for a good three-course meal being 7½d., while a satisfying repast can be had for a few pence.

Fig. 1.—"Brompton and Kensington" Cooking Plant at Poplar.

A special feature of the kitchen is the adoption of electric cooking for the major portion of the work. The plant comprises the following items:—

Three-oven electric range, each oven measuring 1 ft. 8 in. × 1 ft. 6 in. × 2 ft., and taking 3 kw. per oven, with three-heat regulation;

Carving table and hot cupboard, 6 ft. 6 in. × 2 ft. 6 in., loaded to 4 kw.;

Three-compartment baking oven, each compartment measuring 4 ft. 5 in. × 2 ft. 5 in., with three-heat regulation;

Two grills, each taking 5·2 kw., in two sections;

Two boiling plates, 1 kw. each, and

Three ditto, 1·4 kw. each, with three-heat regulation.

The above all being supplied by the Brompton and Kensington Accessories Co., Ltd.

One baking oven, measuring 1 ft. 10¼ in. × 1 ft. 9 in. × 2 ft. 8½ in. high, loaded to 6 kw., with 6 heats, supplied by Messrs. Belling and Co.

The remainder of the apparatus includes steam boiling pans and a vegetable steamer, and electrically-driven machines for mincing, peeling potatoes, &c.

The accompanying illustrations show the arrangement of the plant, which is installed behind the service counter at one end of the hall; fig. 1 shows most of the B. and K. apparatus, with the steam cookers in the background, while in fig. 2 the Belling oven is seen at the extreme right hand of the view. The latter is a new pattern which has been standardised expressly for use in communal kitchens; it is built of sheet metal, with angle-iron legs, and is thoroughly lagged all over. Thanks to the lightness of the construction, it quickly heats up without absorbing a great quantity of energy, and the interior, which forms a single compartment is provided with racks accommodating the stock sizes of utensils. The heating elements, 24 in number, are distributed over each side of the oven in two vertical rows; they are rated at 250 watts each. A series-parallel switch controls each side of this oven; with all the elements full on a temperature of 400° F. is attained in 15 minutes. In the middle position of the switch, half the elements are full on, and in the "low" position the two rows of elements are put in series, giving sufficient heat to keep the oven at cooking temperature. As most of the cooking is done with the switches in the "low" position, the life of the elements is very long, and the arrangement described ensures uniform temperature throughout the oven.

The element consists of a strip of mica spirally wound with wire, and attached to "floating" bus-bars, so that expansion and contraction due to changes of temperature set up no strains on any part of the elements. The elements are protected by sheets of perforated steel, and the connections are led away from the bottom ends of the bus-bars through porcelain tubes into a switch-connection chamber. The capacity of the oven is stated to be 100 lb. of beef or seven large pies or puddings, and it weighs 2 cwt.

On the side of the Belling oven is mounted an indicator showing the cost of running it in pence per hour, at 1d. per unit, according to the "heat" which happens to be in use—a striking feature, particularly in view of the fact that this large oven takes only 1½ kw. most of the time.

The plant is supplied with energy from the Poplar Municipal Electricity Works, the load being balanced approximately on the two sides of the three-wire system; energy is supplied at ½d. a unit, plus a small standing charge. The results obtained have been all that could be desired, and the success of the establishment is already assured. We were pleased to learn from two of the Inspectors under the Ministry of Food—Miss Ball and Mr. Johnson—who were present on the occasion of our visit, that, while steam was preferred for boiling on the score of economy, they could not speak too highly of the merits of electric cooking, on account of its cleanliness, convenience, uniformity and other well-known advantages. In particular, they fully endorsed the claim that the electric oven effects a material saving in the case of meat, besides retaining the flavour and succulence of the joint in the highest degree.

We are indebted to Mr. J. Horace Bowden, borough electrical engineer, and to the lady in charge of the kitchen staff, Mrs. Cattermole, for facilities in preparing this article and obtaining photographs of the equipment.

## NEW ELECTRICAL DEVICES, FITTINGS, AND PLANT.

*Readers are invited to submit particulars of new or improved devices and apparatus, which will be published if considered of sufficient interest.*

### B.T.H. Current-Limiting Reactances.

The accompanying illustration (fig. 1, p. 345) shows three cast-in concrete reactances, each rated at 49 k.v.a., installed on feeders in a generating station by the British Thomson-Houston Co., Ltd.,

Fig. 2.—B. & K. Apparatus, and Belling Oven.

of Rugby. This type of reactance, it is claimed, possesses thorough reliability, great mechanical strength, complete freedom from fire risk, and ready accessibility for inspection. The coil is in the form of a short solenoid with widely spaced turns, the whole being solidly held together by wedge-shaped blocks or pillars of specially cured concrete cast in radial positions around the conductors, and bolted to a heavy concrete base-ring. The lengths of unsupported conductor between pillars are kept well within safe limits. Although concrete cannot be looked upon as a highly insulating material, its use in these coils is rendered thoroughly safe by the thickness used between turns and layers. The layers are not in planes normal to the coil axis, but are wound slightly conically, so that the thickness of concrete increases with the voltage between

conductors. This is readily seen in the illustrations, which give the coil the appearance of having layers wound in pairs. The whole coil is supported on stout porcelain insulators having ample leakage distance.

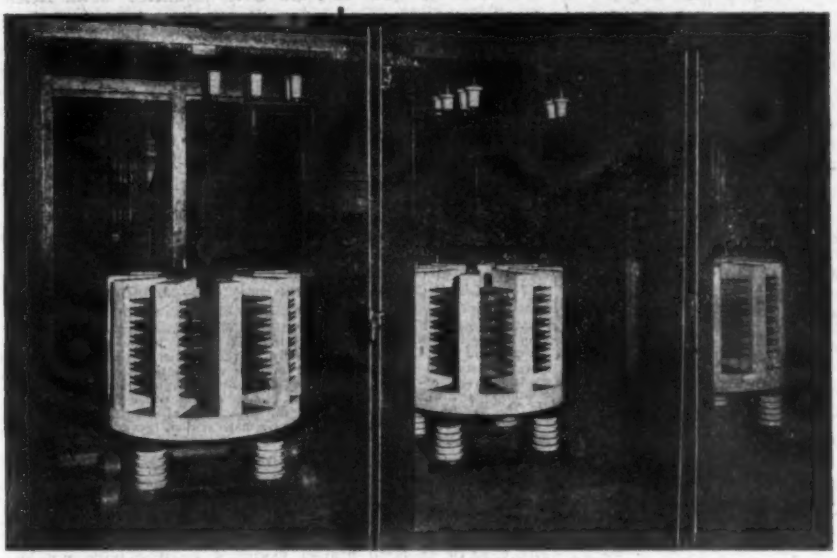

Fig. 1.—B.T.H. Reactances on Feeders.

The use of an air magnetic circuit ensures that the voltage absorbed by the coil is strictly proportional to the current, however large the emergency value of the latter may be. The temperature rise of the copper (at the hottest point) when carrying the normal current of the circuit does not exceed 75° C., which complies with the Engineering Standards Committee Rules for the materials used. In some cases, however, the size of conductor is dictated by the short-circuit current which the coil may have to carry for a given time without reaching a deleterious temperature. This short-circuit current is always assumed to be the maximum possible—*i.e.*, for a three-phase circuit it is equal to the voltage to neutral divided by the reactance in ohms. Owing to good ventilation and open construction, there are no hot spots produced in the winding.

The losses in B.T.H. reactances, due to $I^2R$ in the conductor, are low, averaging in kw. about 4 per cent. on 50 cycles and 7 per cent. on 25 cycles of the rated k.v.a. capacity of the reactance. The k.v.a. capacity is taken as equal to (normal current)$^2$ × reactance in ohms ÷ 1,000.

Provided the reactances are installed at a distance from ironwork equal to their radius, no perceptible stray-field effects are produced. With full-load current in the coil, a modern shielded instrument may be brought quite close without its indications being affected more than 2 per cent.

### Magnifying Scale Deflections.

A simple means of increasing the deflections of an electrometer is often wanted under circumstances where the use of a sufficiently long distance from mirror to scale is inconvenient. This may be accomplished by interposing a concave lens between mirror and scale, thus magnifying the deflection. A lens of rather long focus placed, if anything, nearer the mirror (fig. 2) is preferable, as the effects of chromatic aberration are thereby diminished and the

Fig. 2.—Device for Magnifying Deflections.

proportionality of the deflections is also better preserved. The image will be much brighter if a cylindrical lens is used.

By this means a Dolezalek electrometer with platinum fibre was raised from 3,000 to 18,000 mm. per volt at a scale distance of 4 m. Owing to diffraction, the spot was about 1 mm. wide, but its position could be read to 0·2 mm., and the proportionality between deflection and potential was very good.—E. H. Kennard, in *Science*.

### A Simple Carbon Terminal.

In view of the difficulty now experienced in obtaining the ordinary brass screw terminals for the carbons of primary cells, an ingenious substitute devised by The British Utilities, Ltd., of 148, South Park Road, Wimbledon, S.W. 19, for their "Bul" cells will be of interest. It consists, as shown in fig. 3, simply in drilling a hole in the end of the carbon rod and bushing it with an ordinary shoemaker's eyelet on each side, the two eyelets telescoping one within the other. This makes an effective metallic connection with the carbon, to which a lead can be soldered, and it has the advantage that the makers can supply the rods thus eyeleted to customers who are unable to furnish priority certificates.

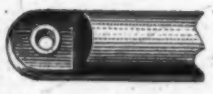

Fig. 3.—Eyeleted Carbon Rod.

## LEGAL.

County of London Electric Supply Co., Ltd., *v.* James.

In the City of London Court, on Tuesday, before his Honour Judge Atherley-Jones, K.C., plaintiffs sought to enforce payment of £1 10s. 2d. for electrical energy supplied.

Defendant said he really did not owe the money. The dispute arose out of the plaintiffs charging him for brushes. A motor was of no use without brushes. He was willing to pay if he should. He had had brushes from the plaintiffs to run his motor for 12 years, and only during the last 12 months had they sent him an invoice for accessories. It was not a matter of money but a matter of principle.

Judge Atherley-Jones said that was not the occasion on which to raise the question. Defendant had allowed judgment to be given against him.

Plaintiffs' representative said that the claim was made strictly in accordance with the agreement which the defendant had signed, under which the current was supplied to him.

Defendant added that the plaintiffs supplied him with a brush a month ago, and he received an invoice for two. He thought they were supplied under the hiring agreement, and that no charge ought to be made for them.

Judge Atherley Jones said that any *bona fide* defence which the defendant had he could have raised at the trial. He must order payment of the money in a month.

Hogan & Wardrop *v.* J. R. Offer & Sons.

In the City of London Court, on April 9th, before his Honour Judge Atherley-Jones, K.C., plaintiffs, electrical suppliers, 2, Gresham Buildings, E.C., sued defendants, engineers, of Kingston-on-Thames, for £11 8s. for two electric fans supplied for ventilating purposes.

Mr. Carnegie, for the plaintiffs, said that the fans were ordered in June of last year. Defendants now said they were unsuitable for the purpose for which they were supplied. They complained about the fans, and plaintiffs said they would be quite willing to put right anything that was wrong.

Mr. Sherwood, for the defendants, said that they had been put to great trouble and annoyance because their customers complained.

Mr. Carnegie said that the plaintiffs' view was that the defendants had accepted the fans.

Mr. Sherwood replied that the blades were not balanced, the fans were always stopping, and they required rebushing.

Major Hogan, one of the plaintiffs, said that the defendants had refused to return the fans, and that had led to all the trouble.

Mr. Carnegie said the plaintiffs were relying on the fact that the defendants had been very unreasonable in regard to the time within which they made complaint.

The Major said that the fans were quite satisfactory before they

went out. The motor had had an exhaustive test. If electric fans were not properly used they would easily get out of order.

In cross-examination, he said that the periodicity for Kingston was 77, and the fans were set accordingly. If the periodicity was wrong the fans would never have worked at all. The pressure was 105 volts. He had never heard that the fans would only run at half speed. Any electrician's mate could have told at the outset whether the fans were wound to the correct periodicity. He assumed that a customer like the defendants knew what the periodicity of Kingston was, and then it was not the plaintiffs' duty to inquire at the Town Hall. They were given the details on which to work. He did not know that within three weeks of starting the bearings were badly worn. There was no limit theoretically to the life of an electric fan. It was a well-known principle of the electrical trade that if a fan was unsatisfactory, it should be returned at once. That was not done.

Henry Harding, electrical engineer to the defendants, said that the fans, which were 12-in. box ones, were unsatisfactory from the first. After he connected the fans they would not start without a push off, and they never ran at more than half speed. The blades were out of true, and that knocked the bearings out in a very short time. The fans ought to be wound for the periodicity of the district. The fans were wound for 50 instead of 77 periods. The brass was very soft metal. His customer would not allow him to take the fans out. In fact, they ordered him out of the premises, so displeased were they.

Judge Atherley-Jones did not doubt the *bona fides* of the defendants, but there was a golden rule in commerce that when there was any defect in an article complaint should be made at once, and that was not done. Judgment for the plaintiffs, with costs.

## WAR ITEMS.

**Restrictions Relating to Electric Converter Plant.**—The Minister of Munitions has issued under date April 5th a "Converter Plant Control Order, 1918," which reads as follows:—

"1. No person shall on or after the date hereof until further notice purchase or manufacture, or erect or install in or in connection with any factory, workshop, steel works, shipyard, colliery, or other premises for the purposes of which alternating current is or can be made available, any rotary converter plant, motor generator plant or converter plant of any description for transforming alternating current to direct current, or any part of such plant (all or any of which shall be included in the expression 'converter plant') except under and in accordance with the terms of a licence issued on behalf of the Minister of Munitions by the Director of Electric Power Supply.

"2. Nothing herein contained shall prevent the carrying out of any necessary repair to converter plant already installed at the date hereof, or the purchase, manufacture, erection, or installation of converter plant required solely for electro-chemical of electrolytic processes or electric traction.

"3. All applications in connection with this Order shall be made to the Director of Electric Power Supply, Ministry of Munitions, 8, Northumberland Avenue, W.C. 2.

"Note.—The licence required by this Order is in addition to and not in lieu of the usual Priority Certificates and permit reference number.

"Applicants for licences are warned against purchasing or installing direct-current motors before the licence for the necessary converter plant has been obtained."

**Trading with the Enemy.**—The "London Gazette" for April 5th contains names of persons and bodies in the following countries with whom trading is prohibited:—Argentina, Uruguay, Bolivia, Chile, Honduras, Mexico, Morocco, Netherlands, Netherlands East Indies, Salvador, Spain, Sweden, and Venezuela.

**Electricity Supply from Public Mains.**—In future, all applications to the Ministry of Munitions for Priority Certificates to enable motors and other electrical plant (requiring a supply of current from the public mains) to be purchased should be accompanied by a certificate from the chief engineer or manager of the public service undertaking concerned stating:—

1. That adequate generating plant capacity is or is not available.

2. That no additional cost or material is involved in connecting the premises to the mains (including sub-station equipment, if any), or

3. Where expense is involved, the material and apparatus to be provided and the cost thereof, and whether lead-covered cable is necessary or not. Where lead-covered cable is deemed necessary, the voltage of the current transmitted should be stated.

Applicants should, whenever possible, also obtain the written support of the Government Department interested in their manufactures, and forward a copy of same.

The purpose of the above procedure is to reduce the demand for current—other than that used for urgent war purposes—supplied by the public service undertakings, and the time occupied in making inquiries.

**Labour in Germany After the War.**—As we have found in the United Kingdom, so in Germany, the consequences to the nation of friction between employers and employed have been brought into bolder relief during the war. No belligerent Power has been without its labour troubles. Economic reconstruction after the war, it is now held, postulates the solution of the labour problem. This is appreciated in Germany as profoundly as in the United Kingdom. The German Trade Unions have put forward a claim to have a voice in Reconstruction questions, and have submitted to the Reichstag a complete scheme embodying their recommendations for the transition period and after the war generally. More recently they have been concerned in placing a Bill before the Bundesrat for the establishment of Chambers of Labour, with conciliation committees and arbitration courts composed of employers and employés, much on the lines recommended for the United Kingdom in the now celebrated Whitley Report.

Discussing the tasks of the German Trade Unions in the economic struggle of the coming peace-period, Herr August Winnig, a well-known trade union leader, states that their attention should be turned to the question of the profitable production of German goods, not less than to the problem of wages. The revival of keen international competition will, in his opinion, bring German industries face to face with great difficulties, which can only be surmounted by the adoption of more scientific methods of production. He adds:—

Trade Unions have hitherto viewed such efforts with considerable suspicion as tending to exploit labour more than ever; but if the sound underlying principle of utilising more completely the total energy spent on labour is once grasped, no objection can be brought against the suggestion from the point of view of labour. The thought that labour, not merely as a wage-earning body, but as an indispensable part of the whole machinery of production, is as much interested in the prosperity of industrial undertakings as the owners, and ultimately the German nation, is now frequently expressed in trade union and socialistic organs.—*Board of Trade Journal.*

**Exemptions Withdrawn.**—An Order has been issued by the Minister of National Service withdrawing exemptions from military service held wholly or partly on occupational grounds by certain men of various ages employed in a large number of occupations, who are in medical categories A, B 1, and C 1, or medical grades 1 and 2, or who have not been medically examined.

The Order, which is far-reaching in its effect, provides that the exemptions of the men concerned are withdrawn as from 24th inst., after which date the men will be called up for military service. The current regulations provide that applications for renewal of exemptions withdrawn by the Order (which can be made on authorised personal grounds only) may be lodged within seven days of withdrawal—that is, in this case by May 1st. A de-certified man has no right to apply for renewal of exemption on occupational grounds, nor has his employer any right to make such an application on his behalf. A limited discretion has been given to each Director of National Service, in the regions into which Great Britain is divided, to suspend the calling up of a de-certified man who is employed on Government contract for urgent war supplies. Applications for this suspension must be made before April 24th in a special form, and suspension will only be granted under exceptional conditions.

**Exemption Applications.**—Mr. Hayes Fisher, President of the Local Government Board, has addressed a circular letter to local tribunals stating that the Minister of National Service has directed the local National Service Representatives to apply, except as regards certain cases which have been before tribunals within the last month, for the review of exemptions held on occupational grounds by men in Grades 1 and 2, or in categories A, B 1, and C 1, or who have not been medically examined. He impresses upon tribunals the necessity in the present crisis of the extreme urgency of promptly dealing with all these cases, and with any others which may come before them, particularly as regards men in the grades referred to, and asks that, where possible, such cases will be disposed of within the next fortnight.

Cambridge Tribunal has granted three months' exemption to A. E. Everitt (32), electrical engineer.

At Dover, on a review, four months, unless substituted, were granted to W. J. Revell (26, B 2) and W. C. Piddock, drivers of electric scavenging vehicles. Four months were also conceded to G. F. Howard (35, C 1), assistant fitter on the Corporation tramways.

Torquay Tribunal has decided that if the men are classified in Grade 1 or 2, W. Hannaford, driver, and E. J. Rawlings, traffic inspector, engaged with the Tramway Co., shall be available for the Army.

The Epsom Rural Tribunal has granted three months' exemption to Mr. W. J. Webb, electrician, of Bookham Lodge, Cobham.

At Hastings, the manager of the tramways, Mr. H. Vincent Edwards, appeared in reference to the review of the cases of six Grade 1 men, four in Grade 2, and eight in Grade 3, and one rejected. Mr. Lloyd, for the Military, asked whether some arrangement could be come to whereby Grade 3 exemptions were assented to if Mr. Edwards released the others, some at a time, so that there should be a minimum of inconvenience. Mr. Edwards said that he could not assent to it with regard to two men. One, Webb, the engineer, was the only man with any electrical training, with the exception of himself, on the whole job, and if the system was to be run it was imperative that they must have somebody who was skilled. The other man was a turner who had been trained to do the work because there was nobody else. The Tribunal granted six months to a linesman, Webb, and the turner, the other Grade 1 and 2 men were exempted for one to two months each, and the Grade 3 men for six months.

## STEAM CONDENSATION.

By A. ARNOLD.

The increasing size of units employed in central-station practice has resulted in something approaching standardisation of condensing arrangements, and has brought to the fore a mass of data and experience. It has also caused a healthy realisation of the effects of operating plant under different vacua, because this is so easily demonstrated by the indications of the many measuring instruments which can be, and are, justifiably employed upon big units. But it is nevertheless a fact that many otherwise well-informed technical men are regrettably vague in their ideas regarding condensation, as such, although perfectly familiar with the operation of the plant. The notion is very prevalent that there is something mysterious, or, at any rate, theoretically abstruse, in the process; it is the purpose of this article to show that this is not so, and that in fact nothing more is required for a complete practical understanding of the matter than an elementary knowledge of physics and engineering common-sense.

After all has been said, condensation of steam is merely the change of state of a fluid—water—from a gas or vapour to a liquid; were it not for quite extraneous and incidental complications, this change would be so simple that it would call for no comment. It would merely involve provision for the removal of the latent heat of the gas, and if it were a practical matter would require considerably less cooling surface and less pumping plant than has, unfortunately, to be actually provided. Water, the working fluid universally utilised for large-scale heat cycles, has a latent heat which increases as the pressure decreases, and, like every other fluid when in a gaseous form, has a definite temperature corresponding to any given pressure, and *vice versâ*. At 29 in. vacuum its temperature is about 79° F. and its latent heat 1,060 B.TH.U. per lb. Considering that this heat must be absorbed at a temperature not higher than 79° F. in order that the change of state may take place at all, it follows that considerable apparatus would be necessary even in this simple case. A great many heat units are unavoidably wasted in heating up the circulating water, and these low-grade units cannot, in the present state of our knowledge, be efficiently utilised. The fact that steam liquefies at reasonably low temperatures only at such low pressures is not exactly ideal for heat-engine purposes, unless, indeed, some new type of plant can be evolved wherein the latent heat released by the change of state is turned to account; according to present experience, a working fluid which liquefied at or about atmospheric pressure and at a low temperature would be preferable. Unfortunately, we do not know of such a fluid which could be practically utilised.

The idea is common that the lower the pressure at which an engine exhausts the better; sight is lost of the fact that we are dealing with heat engines, and the desirable low pressure is, therefore, quite an incidental item, corresponding as it does with the lower practical limit of temperature possible with water as the working fluid; in other words, it is the low temperature that is desirable, not necessarily a very low pressure of exhaust. In practice, this low pressure (or "vacuum") gives rise to considerable complications. The exhaust steam, now water, must be pumped up to atmospheric pressure or more before it can be available for further use, and a portion of the engine, and, in some cases, considerable piping is under a greater external than internal pressure, so that any small leakage means the entry of air into the system instead of merely a small escape of steam. It is this leakage air, in addition to a certain amount which may separate out in the process of boiling, which necessitates the provision of compressors to bring it up to atmospheric pressure; this is the function and the justification of the existence of what are termed "air-pumps."

Everyone who has had any training in elementary physics, and however long ago that training was, will remember that Dalton's Law deals with the case of mixed gases, with regard to vapour pressure. Each gas, as mentioned previously, has its own particular pressure at any given temperature, and if two be mixed the resultant pressure will be the sum of these "partial" pressures at that temperature. In this case of air and steam, therefore, we may say that at a given temperature the pressure existing in an apparatus such as a condenser will be equal to the pressure due, first, to the air, as if it occupied the volume alone at that temperature, added to the pressure due to the vapour of water at that temperature, just as if it, too, were alone. Now, in the simple case in which there was no air, we merely had to maintain a temperature corresponding to the vapour pressure of water at the "vacuum" desired (*e.g.*, 79° F. at 29 in.); but if there were air present there would be a pressure in excess of 29 in. vacuum at 79° F. due to it; otherwise the whole pressure existing would have been accounted for by the vapour, and the air must be at zero pressure, and hence it would have an infinite volume (for $pv = c$, according to Boyle's Law), which is hardly within practical politics from the point of view of a compressor or air pump to deal with it. To preserve our 29-in. vacuum we must, therefore, maintain a lower temperature than 79° F. if there be air present, as is inevitable in practice, and the size of the compressors necessary for returning this air to the atmosphere will depend both upon the weight of air entrapped and its initial volume—*i.e.*, upon the vacuum carried. An ordinary air pump, or, more correctly, a low-pressure compressor, will deal practically with a given volume of vapour, whatever its pressure, within limits, of course; so that if at any time the amount of air entering a vacuum system exceeds that which the air pump is delivering at atmospheric pressure, the internal pressure will rise (*i.e.*, the vacuum will fall), until it is such that the volume of the air is decreased to the capacity of the air-pump. To compensate for small air leakages, therefore, the air-pumps may be speeded up, if they be of the reciprocating type, thereby increasing their effective capacity.

In practice, of course, the temperature of a condenser is not maintained uniform at all parts—the process is gradual. The cold surface provided is much less efficient as a medium for cooling air than for condensing steam, and itself varies in temperature in different parts. Normally the hottest circulating water should be adjacent to the entering steam, and here the temperature of the mixed steam and air will be exceedingly close to the theoretical figure for steam alone at that vapour pressure, for the volume of the air will be negligible compared with that of the steam. This fact is useful, as a standard thermometer close to the vacuum gauge pipe on the turbine exhaust will serve as a most reliable check upon that gauge's indications, by means of the ordinary steam tables. A large amount of heat is transferred to the circulating water from the steam as the latter passes the first few rows of tubes, and a corresponding and definite amount of steam is condensed into water. In an ideal condenser this water would pass directly to the "wet"-pump suction, at its highest temperature, but in most practical designs it has to trickle over more or less numerous other tubes, being needlessly cooled, and screening a certain amount of surface from direct contact with the steam and air; on the other hand, it will receive heat from other of the vapour which it may condense. As water is formed, the volume of the air becomes more comparable with the remaining steam, until at the bottom of the condenser the air occupies the whole space, all the steam having been condensed and preferably drained away. Hence the volume of the air per unit of weight will depend upon the coldest temperature of the circulating water, and the temperature of the condensed water will be as high as possible. Since the air must be removed by mechanical means, it must needs have a finite volume and pressure, and for this reason, if for no other, it is impossible to obtain a vacuum equal to the barometer.

The percentages known as "Vacuum" and "Condenser" Efficiency respectively are very useful guides when investigating the cause of a slowly developing drop in vacuum attained under working conditions, but, as conventionally expressed, they must be interpreted together in the light of previous results, and intelligently, for it is not impossible to obtain figures exceeding 100 per cent.; the ratios are, to an extent, arbitrary and empirical, but will be found useful, nevertheless. "Vacuum" efficiency is expressed by the ratio of observed vacuum (by mercury column) multiplied by 100 and divided by (the barometric height minus the

vapour pressure corresponding to the temperature of the air-pump suction,) and any falling-off in this figure indicates that the plant cannot cope with the amount of air to be compressed; in other words, that an air leakage is occurring. "Condenser" efficiency is taken as the observed vacuum multiplied by 100 and divided by (the barometric pressure minus the vapour pressure corresponding to the temperature of the outlet circulating water); its gradual deterioration would indicate one of two things. The condenser tubes may be becoming scaled up or blocked up by dirt, or the circulating pump may be failing to deliver the correct quantity of water. A rise in the friction head lost by the circulating water across the condenser will indicate the former, a fall the latter; but more often a combination of these causes reacts to give higher circulating outlet temperatures.

It may be noticed in the foregoing that it has been taken for granted that separate pumps are provided for dealing respectively with the condensate and the air. This is now standard practice in one form or another for most sets over 2,000 KW. capacity, and certainly for all big sets, *i.e.*, over, say, 6,000 KW.—although, by the way, our American Allies would probably multiply that figure by a constant of about 4 or 5 before considering the adjective justified! In a number of special types of air pumps steam jets are used, and in many cases pumps are turbine driven and the auxiliary exhaust is used for heating feed water or make-up; this steam is generally used by direct contact, and is thereby itself condensed, and in practice it is often difficult to prevent such heaters from knocking or hammering. The secret lies in designing the heater with a suitable steam velocity, sub-dividing the orifices by which the steam issues in such a manner that all the steam is immediately in contact with an adequate amount of water, and making provision for a sufficient circulation of the whole of the water to be heated. Where steam jets are employed as air pumps, and the steam is subsequently condensed, it is imperative that the resulting water be given the opportunity to become de-aerated before being used as boiler feed, or corrosion will result; it should also be heated, preferably by direct contact with exhaust steam at atmospheric pressure or less.

Rotary air pumps are now used very generally, and, provided they have an adequate margin and can quickly remove the dense air when starting, are very satisfactory. It is possible with this type of plant, working well below capacity, to obtain vacua apparently greater than that theoretically possible at 100 per cent. efficiency, that is having regard to the temperature of the water in use in the pump. The explanation is that evaporation from the surface film of this water so cools that film that the pump operates as if supplied with water at the lower temperature, the velocity of the water being too great for conduction appreciably to affect the process.

## BUSINESS NOTES.

**Book Notices.**—"Circular of the Bureau of Standards." No. 67. "Combined Table of Sizes in the Principal Wire Gauges." The table combines in one series the sizes in the American (B. & S.), steel, Birmingham (Stubs's), British standard, and metric wire gauges, arranged in order of diameters of wires. It gives the diameters of all the gauge numbers in these five systems in mils, inches, and millimetres, also the cross sections in square mils, circular mils, square inches, and square millimetres. The table is specially useful to manufacturers who wish to determine the nearest equivalent in American or British gauge sizes of wires. Washington: Government Printing Office. Price 5 cents.

"The Just Claims of Italy: the Question of the Trentino, of Trieste, and of the Adriatic." By Whitney Warren. Price 50 cents.

"Essentials of Electrical Engineering." By J. F. Wilson. London: Constable & Co. Price 10s. 6d. net.

"*Proceedings* of the Physical Society of London." Vol. XXX, Part 2. February 15th, 1918. London: Fleetway Press, Ltd. Price 4s. net.

**U.S. Lead.**—By agreement with the lead industry, the United States Government will be furnished with from 6,000,000 to 12,000,000 tons of lead per month, at prices averaging 7c. (3½d.) per lb.—*Times.*

**Dissolutions and Liquidations.**—Clarke, Forde, Taylor & Erskine-Murray, civil and electrical engineers, 4, Great Winchester Street, E.C. Messrs. J. A. L. Dearlove and J. Erskine-Murray have dissolved partnership. Mr. Dearlove will continue the business under the former style of Clark, Forde and Taylor. Mention of this matter is made in our "Personal Column" to-day.

Standard Cable Manufacturing Co., Ltd.—A petition presented by the Board of Trade in the matter of the Trading with the Enemy Amendment Act, for the winding-up of this company, is to be heard on April 16th.

Electric Utility Co., Ltd.—A meeting is called for May 23rd at 50-51, High Holborn, W.C., to hear an account of the winding up from the liquidator, Mr. A. Jonckheere.

**Catalogues and Lists.**—Messrs. James W. Carr and Co., 35, Queen Victoria Street, London, E.C. 4.—Thirty-six-page brochure giving descriptive notes, with illustrations and prices, of various accessories for the machine shop.

Messrs. Cole, Marchent & Morley, Prospect Foundry, Bradford.—Catalogue No. 53 (24 pages) containing a full description, with half-tone illustrations, of the Morley-Güldner slow-speed vertical four-cycle constant-pressure oil engines.

The Power Plant Co., Ltd., West Drayton.—Twelve-page pamphlet (No. 11) containing a description of their double reduction marine turbine gears.

**Trade Announcements.**—Messrs. Napier-Kimber, Ltd., notify that their head offices and wholesale electrical supplies department are now at 109, Great Portland Street, London, W. 1. Telephone No.: Mayfair 3860. Telegrams: Aperimber, 'Phone, London.

Messrs. Cecil Hodges & Co., Ltd., state that as the War Committee require their premises (Balfour House, Finsbury Pavement, E.C.), where they have been for the last 15 years, for the purpose of a Government Department, they have removed to Empire Works, Dalston Lane, London, E. 8. Telephone No.: Dalston 2464. Telegrams: "Ammeter, London."

Messrs. Ferguson, Pailin & Co., Ltd., electrical and general engineers, Openshaw, Manchester, have opened an office at 37, Norfolk Street, Strand, W.C. Telephone No.: City 547.

## LIGHTING AND POWER NOTES.

**Armagh.**—The Urban Council has referred to Committee an application by the Gas Light Co. for permission to use the streets to enable them to install electric lighting.

**Australia.**—The Sydney (N.S.W.) city electrical engineer reported that, as a result of the recent strike, the working of the electricity undertaking for the month of September last showed a loss of £11,991, as against a profit of £1,588 in August. In October there was a slight profit—viz., £75. A contributory cause was that the charges for coal cartage increased the price of coal at the furnaces from 15s. 7d. to 24s. 4d. per ton.

The purchase of a colliery by the Sydney City Council, so as to secure a permanent supply of coal for the power house, has recently been under discussion by the Council. It was stated that the advisers had recommended the purchase of the Balmain Colliery on account of its nearness to the generating station; the vendors had asked £100,000, and it was estimated that the cost of necessary alterations would be about £65,000. If the City Council acquired the colliery the output was estimated to be 1,000 tons a day, at a cost of 10s. 9d. per ton.

The work of cutting a tunnel under Sydney Harbour from Long Nose Point to Greenwich Point for the purpose of carrying the cables to supply electricity to the North Shore has had to be abandoned, so far as the original line is concerned. The failure is due to a narrow fissure in the rock bed about 200 ft. below the water level; the tunnel works had reached the deepest point, and were nearly halfway across, when an inrush of water took place, which all efforts have failed to clear. A fresh start has now been made, a slight deviation being made from the old working. The new tunnel will follow practically the same line as the former one, but will go fully 30 ft. deeper at the point where the inrush of water occurred.

The Under-Secretary to the Local Government Department has advised the Newcastle (N.S.W.) Municipal Council that the Council's borrowing powers are not limited to £160,000, including electricity supply, under the Local Government Act; the Council is empowered to carry on the electricity undertaking not only under the Local Government Act, but also under the City of Newcastle Electric Lighting Act. The only restriction is that the Government's approval has to be obtained before borrowing.

Respecting the proposal to establish some central authority to take over electric power production, the Minister says that, in his view, the proper authority to be created for this purpose is a Greater Newcastle Council, and he hopes, as soon as Parliament has dealt with the Greater Sydney Bill, to introduce a similar measure for the City of Newcastle and suburbs. As it will not be possible either to finance or to obtain machinery during the war for any large electricity supply scheme, the Minister fully expects to be able to secure the passage of a Greater Newcastle Bill in time to allow the Council to embark on a large scheme of power supply.—*Sydney Daily Telegraph.*

The Minister for Public Works (Victoria) has submitted to the Executive Council for approval an Order to enable the Melbourne

Electric Supply Co., Ltd., to supply electricity in the Black Rock district of the Borough of Sandringham. The maximum prices which may be charged per quarter under the Order are :—Up to 20 units, 15s. ; for each unit over, 9d. per unit.

**Aylesbury.**—Plant Extension.—An official inspection took place on Thursday, April 4th, of new plant recently installed at the borough electricity works. This undertaking was started after the war commenced, and it has already been found necessary to extend the plant. In the new plant a conversion from Diesel to gas engines has been made, resulting in a considerable reduction of the fuel bill. A description of the new plant will appear in our next issue.

**Belfast.**—L.G.B. Inquiry.—A L.G.B. inquiry was held by Mr. P. C. Cowan, Chief Engineering Inspector, on Thursday, April 4th, into the Corporation's application for sanction to a loan for £310,750 for extensions to the city electrical undertaking.

**Bradford.**—Loan Application.—The Electricity Committee recommends the City Council to make application to the L.G.B. for sanction to borrow £152,651 for the provision of a new 15,000-KW. turbo-generator, with condensing plant, auxiliaries and coal conveyor.

**Bridlington.**—Price Increase.—The T.C. has revised the tariff for energy as under from the March meter readings :—General lighting, up to 500 units per quarter, 6½d. per unit ; over 500 and up to 1,000, 6d. ; over 1,000 and up to 1,500, 5½d. ; beyond, 5d. Heating and cooking, up to 1,000 units per quarter, 2½d. ; beyond, 2d. Power, up to 250 units per quarter, 2½d. ; beyond, 2d.

**Canada.**—The *Electrical World* states that the London Electric Co., Ltd., a corporation controlled by Mackenzie & Mann, was to terminate its business in London, Ont., about March 15th, and its plant would be dismantled and scrapped. The company formerly sold power to customers taking approximately 2,500 H.P. at 9 cents per KW.-hour net, plus meter rates. When the Hydro-Electric Commission entered the field, it charged 4·5 cents per KW.-hour, and gradually reduced charges to 1·5 cents per KW.-hour, and the London Electric Co. was unable to compete. When the private company was unable to obtain coal for its plant during the recent shortage, the directors decided to suspend operation. It is reported that the Ontario Government has ordered Mackenzie & Mann to turn over two of the generating machines at Niagara Falls, Ont., to the Hydro-Electric Commission.

**Continental.**—Italy.—Water-Power Utilisation.—According to a recent return, 51 concessions to establish plants to utilise water power in Italy to the extent of 208,036 H.P. were granted last year. The Province of Piedmont heads the list with 62,352 H.P., Lombardy being second with 37,106 H.P., and Umbria third with 34,519 H.P.

**Dartford.**—The West Kent Electric Co., Ltd., has informed the U.D.C. that it will pay as from October 1st, 1917, the higher price asked by the Council in respect of energy taken in bulk over 600 KW. and the equivalent number of units. The supply in excess of 600 KW. will, therefore, be continued.

**Derby.**—Loan Sanction.—The L.G.B. has sanctioned the following expenditure in connection with the extension scheme of the Corporation electricity undertaking :—Conveyors, £880 ; siding, £220 ; land for coal siding, £400 ; turbo-generator, &c., £40,500 ; and mains extension, £9,000.

**Hull.**—Loan Refusal.—The L.G.B. has declined to sanction the borrowing of £19,221 for the installation of two boilers at the electricity works.

**Lancashire Linking-up Scheme.**—The boroughs in Group D of Lancashire electricity undertakings—Accrington, Bacup, Blackburn, Burnley, Colne, Darwen, Haslingden, Nelson, and Rawtenstall—have appointed a Sub-Committee, consisting of a representative of each, with the electrical engineers, to prepare a report as to the cost of interconnecting the undertakings included in the group, and also the advantages expressed in terms of money which may be expected to accrue from such interconnection.

**London.**—L.C.C. and Linking-up.—In a letter to the Borough Councils of Hackney, Poplar, Shoreditch and Stepney, the L.C.C. states that its Finance Committee has had under consideration, in connection with the large loan applications which have been received, the general question of extensions of the electricity undertakings of the Hackney B.C. and of those B.C.'s which are linked up with it, and draws attention to the desirability, from the financial point of view, of effecting the largest possible measure of co-operation between the electricity undertakings, in order to avoid unnecessary extensions involving capital expenditure, and recommends that, before any new proposals for extensions are put forward by any one of them, the question of avoiding such extension by co-operation shall be considered.

Hackney.—Fuel Economy.—The Baths Committee has had under consideration the transfer of the whole of the lighting of the baths premises to the mains of the electricity undertaking, as a means of saving expenditure, especially in the consumption of coal. The Electricity Committee has offered to supply the necessary energy, and the small amount required for power in the laundry, at the rate of £1 per KW. per quarter, and ½d. per unit, plus the war advance, conditionally upon the laundry engine being replaced by an electric motor. The Committee has accepted the offer.

**Morocco.**—The Acting British Consul reports that rapid progress in the installation necessary for the electric lighting of the town of Fez is being made by the concessionaire company. The agreement was made in July, 1914, but, owing to the war, the work was only begun recently on the conclusion of a supplementary convention recognising the increased cost of installation, and making certain more favourable conditions. The engineer in charge of the canalisation of the water power states that it is hoped to obtain electrical plant sufficient to produce 3,000 H.P., and to have it working by next January. The concession also comprises the exploitation of a second group of waterfalls in the neighbourhood, those of the Oued Bou Khenareb, which it is hoped to harness after the war. The power from these falls will be supplied to factories in Fez, and, probably, at Mequinez, 40 miles away.—*Board of Trade Journal.*

**Newcastle-under-Lyme.**—Loan Sanction.—At a meeting of the T.C., it was reported that the L.G.B. had sanctioned the borrowing of £3,000 for the purpose of linking-up the borough electricity undertaking with that of the Stoke-on-Trent Corporation. The Electricity Committee reported that it had received a letter from the Ministry of Munitions urging that electricity works should install Diesel engines, in order to adopt the use of tar oil in the place of imported fuel oil. The recommendation of the Committee that the electrical engineer be instructed to obtain information from works using tar oil and report, was approved.

**Pontypool.**—The Council of the U.D.C. has resolved, subject to the consent of the L.G.B., to proceed with the purchase of the undertaking of the Pontypool Electric Light and Power Co.

**Rochdale.**—Revision of Prices.—The T.C., last week, considered a letter from the Ministry of Munitions recognising the reasonableness of an advance on the pre-war price of electricity supplied under long contracts for controlled undertakings, and suggesting that uncontrolled establishments should voluntarily comply with a revision of their prices in the exceptional circumstances. If an increased price could not be obtained by consent proceedings could be taken under the Courts Emergency Powers Act. The Electricity Committee has decided to approach long-contract consumers on the matter, but that the revision of charges to general consumers be deferred until the result of last year's working is known.

**Salford.**—Loan Application.—The T.C. has decided to apply for sanction to borrow £15,000 for the scheme for bulk electricity supply from Manchester.

**Tasmania.**—The Minister of Mines recently received a deputation of Zeehan residents asking that the King River power scheme should be expedited in order to give cheap power to the Mount Read and Rosebery Mines, Ltd., and, further, that the Government should give every consideration to the company respecting the sale of the Tasmanian Smelting Co.'s plant and assets, which had now become the property of the State. The Minister, in reply, said he did not anticipate any difficulty in financing the King River power scheme, which would cost about £1,000,000 ; the scheme would be pushed ahead, but a good deal of time would be absorbed in collecting data. The Government would have to sell the whole of the 45,000 H.P. which would be developed at King River. At present inquiries covered 30,000 H.P., being 25,000 H.P. for the Mount Lyell Co., which was undertaking the Read-Rosebery Mines, Ltd., scheme for treating zinc-lead and other ores, and 5,000 for the Metals Extraction Co., London ; there was no doubt that the Government would be able to dispose of the remaining 15,000 H.P. Regarding the smelters, the Government had received an offer which would cover all its interests ; the offer would be dealt with by a special Parliamentary Committee.

**Uruguay.**—A recent resolution of the Ministry of Finance states that in view of the necessity of replacing the fuel oil hitherto used by the State Electrical Department with other and dearer combustible, a rise in the prices of energy has become inevitable. In consequence the following rates are now to be charged :—When consumption does not exceed 1,000 KW.-hours per month, $0·055 per KW.-hour ; over that figure, $0·04.—*Review of the River Plate.*

**Wednesbury.**—Sale of Undertaking.—The T.C., on Monday last, decided to dispose of the Corporation's electricity department to the Midland Electric Power Co., Ltd. ; amongst the reasons for coming to this decision is that, with a population of approximately 30,000, there are within the borough four statutory authorities with enabling powers for the supply of electricity and gas for power purposes. The increased prices of materials of all kinds, the increased rates of wages, and the interim report of the Reconstruction Sub-Committee, indicating the creation of larger areas for the generation and supply of electricity, are considered sufficient grounds to justify the Corporation in disposing of the undertaking. The Midland Electric Power Co., Ltd., will take over all the property and assets of the undertaking on payment by the company to the Corporation of all the capital liabilities of the Corporation in connection therewith by 15 annual instalments of £5,000.

**Wigan.**—Loan Application.—The Council has approved the recommendation of the Electricity Committee to make application to the L.G.B. for sanction to borrow £65,000, for the provision of additional generating plant to meet the increasing demand.

**Willesden.**—Loan Application.—The Electricity Committee recommends that application be made for sanction to a loan of £5,400 for two 500-kw. converters at the electricity works.

**Worcester.**—Fuel Economy.—At a meeting of the T.C., last week, the electrical engineer reported the possibility of further restrictions in the supplies of certain classes of fuel, and recommended the replacement of the chain-grate stoker on No. 5 boiler with a four-retort Erith Riley stoker. He explained that the Council already had three of the Erith stokers. His report estimated the saving of fuel at £1,075, whereas the cost of making the alteration would be £820.

**York.**—The city electrical engineer has been unable to obtain priority for repairs to the 1,250-kw. turbine. The engineer reports that if further breakdowns occur at the generating station, the lighting and tramways will possibly be affected.

## TRAMWAY AND RAILWAY NOTES.

**Audenshaw.**—Loan Sanction.—The D.C. has been informed by the Treasury that no objection will be offered to the borrowing by the Council of the moneys necessary to effect the purchase of its portion of the Oldham, Ashton and Hyde Tramways, provided there is no issue of bills, bonds or stocks.

**Australia.**—Year's Working.—The accounts of the Melbourne, Brunswick and Coburg Tramways Trust for the year ended September 30th last show gross revenue £28,674; total expenditure, including interest, £25,199; net surplus, £3,475. Of this, £1,233 has been placed to the renewals reserve account, and an equal amount to the maintenance fund. Car-mileage for the year 538 457; passengers carried, 43,614,593; working expenses per car-mile, including power cost, 8·359d.; total revenue per car-mile, 12·780d.

The report of the N.S.W. Railway Commissioners on the Government tramways, for the three months ended December 31st last, shows revenue £518,607, an increase of £17,767; expenditure, £421,592, a decrease of £14,617; car-miles run, 5,665,573, a decrease of 575,520 miles. The number of passengers carried decreased by 7,635,000.

The attention of the Queensland Home Secretary having been called to a circular issued by the Brisbane Electric Tramways Investment Co. to its shareholders objecting to the two new Tramway Bills introduced in the Queensland Parliament last session, Mr. Huxham (Home Secretary), in reply, stated that the Government simply wanted to give the company that to which it was fairly entitled. If no agreement was arrived at with the Government, the matter would be decided by the Courts. One of the Bills was for clearly defining sections over which a charge should be made of 1d. per mile. The Government wished to protect the public, and see that it obtained a fair return for its money. The Act provided that when local authorities were prepared to take over the tramways from the Government, they simply reimbursed the Government to the amount it had paid either in cash or debenture. In the meantime the tramways would be operated by the Commissioner of Railways.—*Sydney Daily Telegraph.*

**Blackburn.**—Arising out of the recent threatened strike of tramway workers, a conference was held at the Town Hall, last week, between members of the Corporation and representatives of the Employés' Association, and a settlement was arrived at on all points.

**Bradford.**—Bonus.—The decision of the Committee on Production in the recent demand of the women tramway workers of Bradford for the full award of £1 per week advance on pre-war rates, as granted to the men, is in favour of the Corporation's contention that the women are not entitled to the full extent of the advance. The Committee supports the Corporation's offer of an advance to the women of 4s. per week, making a total advance of 13s. per week. The dispute arose out of the terms of employment of the women, but the Committee on Production has decided that these do not entitle the women to the same rates as the men.

**Carlisle.**—Owing to the depletion of the staff of the tramway company, a Committee of the Corporation appointed to consider the question has recommended the Watch Committee to license suitable women as tramcar drivers until July 31st next.

**Halifax.**—Year's Working.—The tramway returns for the year ended March 31st show a record in receipts. The revenue was £126,506, an increase of £14,480 over the previous year. Of the receipts, £2,100 was from the carriage of parcels, an increase of £34. The car-mileage was 1,869,357, a decrease of 179,415, and the passengers carried numbered 22,822,341, an increase of 1,641,757.

**Leeds.**—Parcel Service.—The parcel-carrying scheme on the Corporation tramway system in connection with the efforts being made for co-ordination of transport came into operation on Monday. Special parcel cars are being run twice a day—at 10 a.m. and 4 p.m.—on three of the principal routes in the city, and various depôts *en route* have been arranged for the reception of the parcels. Mr. James Hamilton, son of Mr. J. B. Hamilton, the general manager of the Leeds tramway department, has been appointed manager of the parcel system.

**London.**—Sale of Tramcars.—It was stated at the last meeting of the L.C.C. that six small type tramcars had been sold to Southampton for £550 each. The Council has also sold ten to Rotherham, ten to Sheffield, six to Newport, and five to Bexley and to the Metropolitan and Electric Tramways. The cars had been sold or lent on the suggestion of the Ministry of Munitions.—*The Surveyor.*

**Oldham.**—Fare Revision.—The Tramways Committee has agreed to a revision of fares to meet increased expenditure. The present charge of ½d. for portions of double stages is to be discontinued, 1½d. and 2½d. tickets going to 2d. and 3d. respectively; workmen's return tickets are to be increased by 1d. each, and ½d. fares for children are to be abolished, though children are to be allowed to travel two stages for a penny. Last year's receipts were £23,000 more than in the previous year, but it is expected that the increased expenses will be almost as great.

**Rochdale.**—Increased Fares.—The Tramways Committee has had under consideration the question of increased tramway fares, and, in view of the heavy increases in wages and in the costs of materials, favours immediate steps by the B. of T. to obtain Parliamentary sanction to a 50 per cent. increase of tolls and charges.

Year's Working.—The Corporation tramway receipts for the year ended March 31st amounted to £102,204, an increase of £16,492 on the previous year, and 16,411,024 passengers were carried, an increase of 2,245,526.

**United States.**—In *Electric Traction* for March an account is given of the new high-speed line between Buffalo and Niagara Falls, which is to be opened shortly; this project was initiated no less than 26 years ago. The line has a total length of 22·7 miles, of which 16·5 miles is on private right-of-way; the overhead construction is of the catenary type, the supporting bridges being 200 ft. apart, with a No. 0000 trolley wire at 600 volts. Power is supplied to rotary-converter sub-stations at 11,000 volts. The journey between termini will occupy less than one hour.

**Wigan.**—At the last Council meeting, Councillor Lowe inquired the reason for the Tramways Committee recommending the appointment of a traffic superintendent, seeing that two years ago it decided to dispense with a traffic manager. Alderman Fletcher, in reply, said that what was done two years ago was considered right at the time, but no department had made such rapid strides as had the tramways since then. It had carried 1¼ million more passengers in 11 months than in the preceding 12 months, and this meant a tremendous increase of work and responsibility, and the time had arrived when the department should be reorganised.

## TELEGRAPH AND TELEPHONE NOTES.

**Bolivia.**—Congress has authorised the establishment of wireless stations at Concepcion, San Ignacio, and Villa Bella. These stations, together with the one which will shortly be erected at Trinidad, will form the "second group" of Bolivian wireless stations.

**New Company.**—The Compagnie des Cables Télégraphiques of France is aiding in the formation of the Société de Radio-Télégraphie, which will have a capital of £1,500,000. The former company will subscribe 30 per cent. of the stock, the Marconi group 40 per cent., and the remainder will be taken by banks in Paris. The new company will absorb two concerns which manufacture wireless apparatus, and the Marconi Co. will bring in a wireless station at New York, established by the Marconi Wireless Telegraph Co. of America.—*T. and T. Age.*

**New Telegraphic Printer.**—At the Spanish Club on the 7th inst., Senor Matias Balsera gave a practical demonstration of a new telegraphic apparatus of his invention. The Balsera apparatus is worked on the keyboard system, has already been tested between the central telegraph stations at Madrid and Barcelona, and is said to have received the entire approval of the Spanish telegraph authorities. It is claimed for the invention that it has certain distinct advantages over the Hughes apparatus, the output being electrically, and not mechanically, controlled. The inventor claims that he can send out 45 words per minute, as against the 30 to 35 words sent out by the Hughes. The instrument, in the view of experts who were present, would serve admirably for short-distance transmission, but it is not claimed by the inventor that it could effectively replace the systems now in use for long distances, where the wire, and not the instrument, is the essential factor in rapidity of transmission.—*The Times.*

**Norway.**—A large wireless station has been completed at Jaederen on the Norwegian west coast. There is now an excellent wireless connection between Scandinavia and America.

**Sweden.**—The new Government wireless station at Karlsborg has a range of 5,000 km. The masts are 210 m. in height, and weigh only 25 tons; they are mounted on granite insulators, impregnated with paraffin, and are also interrupted in four places with insulators. The antennæ consist of 60 wires of phosphor bronze, 450 m. long, and are suspended from spiral springs. The counterpoise consists of bronze wire 1 mm. in diameter, which is insulated and supported at a height of 5 m. above the ground, covering an area of 95 ha.; this device has been adopted instead of an earth connection, in order to diminish the losses, and to obtain sharper tuning. Power is derived from the Trollhättan generating station, or from a stand-by plant at the wireless station.—*Dagens Nyhater.*

**United States.**—The report of the New York Telephone Co. for 1917 shows telephone revenue £12,592,200 and expenditure £9,733,500; with other income the total net earnings were over £4,060,000. There were 1,443,388 stations on the system, and with the associated systems the total number of stations was 2,565,913.

## CONTRACTS OPEN AND CLOSED.

### OPEN.

**Australia.**—Melbourne.—June 7th. Department of the Navy. Supply and erection of power plant at Garden Island, Sydney. Director of Navy Contracts, Melbourne.

**Dublin.**—April 23rd. Electricity Supply Committee. Boiler house plant. See "Official Notices" to-day.

**Malvern.**—Electricity meters for a year, for the U.D.C. The Engineer.

**Plymouth.**—April 29th. Corporation. Turbo-alternator, converter, transformers, and switchgear. See "Official Notices" to-day.

### CLOSED.

**Sheffield.**—City Council. Accepted tender; Staveley Coal & Iron Co., Ltd. Circulating water discharge pipes at the Emergency Power Station.

**Wolverhampton.**—Corporation Electricity Department. Accepted tenders:—

Gibbons Bros., Ltd., £52, iron staircase and handrail for the present boiler house flooring to the flooring level of the new boiler house annexe, together with railing on the landing.—J. Spencer, Ltd., £1,580, plus 10 per cent. for contingencies, steam, feed, and blow-off piping for the boiler house extensions.
Foster Bros., £146.—Steam piping for 5,000-kw. turbo-alternator set.
Ferguson, Pailin & Co., Ltd., amounting to £2,868, plus 10 per cent. for contingencies (total £3,154) for installation of four reactances.
Reyrolle & Co., amounting to £919, plus 10 per cent. for contingencies, (£1,010, including the supply of an additional rotary converter, costing £434) for alterations to switchboard to enable reactances to be installed.
Ferranti, Ltd.—House service type meters.
General Electric Co., Ltd.—Switch panel for rotary converter, £184.

A scheme suggested by the electrical engineer for the transport of coal from the railway siding adjacent to the electricity works has been approved, and the necessary automatic plant, rails, &c., are to be purchased for £475.

## FORTHCOMING EVENTS.

**Birmingham and District Electric Club.**—Saturday, April 13th. At 7 p.m. At the Swan Hotel, New Street. Paper on "Electroculture," by Mr. V. J. Hill.

**North of England Institute of Mining and Mechanical Engineers.**—Saturday, April 13th. At 2 p.m. At the Wood Memorial Hall, Newcastle-on-Tyne. General meeting.

**Junior Institution of Engineers.**—Monday, April 15th. At 39, Victoria Street, S.W. At 7.30 p.m. Paper on "Cylindrical Grinding," by Mr. W. D. Adamson.

Saturday, April 20th. Visit to the Lea Bridge Pumping Station of the Metropolitan Water Board.

**Illuminating Engineering Society.**—Tuesday, April 16th. At 5 p.m. At the Royal Society of Arts, John Street, Adelphi. Paper on "Light and Vision: The Physiology of the Retina," by Prof. W. M. Bayliss, F.R.S.

**Electrical Power Engineers' Association (Northern Division.).**—Thursday, April 18th. At the Grosvenor Hotel, Deansgate, Manchester. At 7.30 p.m. Ordinary meeting.

**Chemical Society.**—Thursday, April 18th. At 8 p.m. At Burlington House, Piccadilly, W. First Hugo Müller Lecture on "The Old and the New Mineralogy," by Sir H. Miers, F.R.S.

**Institution of Electrical Engineers.**—Thursday, April 18th. At 6 p.m. At the Institution of Civil Engineers, Great George Street, S.W. Paper on "Overseas Distribution of Engineering Appliances," by Mr. L. Andrews.

(**Birmingham Local Section**).—Wednesday, April 17th. At 7 p.m. At the University. Paper on "Large Batteries for Power Purposes," by Mr. E. C. McKinnon.

(**Newcastle Local Section**).—Monday, April 15th. At the Mining Institute. At 6.45 p.m. Discussion on "The Report of the Coal Conservation Sub-Committee on Electric Power Supply in Great Britain."

**Institution of Mechanical Engineers.**—Friday, April 19th. At 6 p.m. At the Institution of Civil Engineers, Great George Street, S.W. General meeting.

**Royal Institution of Great Britain.**—Friday, April 19th. At Albemarle Street, W. At 5.30 p.m. Lecture on "The Use of Soap Films in Engineering," by Major G. I. Taylor.

## NOTES.

**Electrical Conference in India.**—A conference of Electrical Engineers and Inspectors to Government was opened in Calcutta on January 7th by Mr. J. W. Meares, who referred to the beneficial results accruing from the proceedings at the previous conference (in December, 1916). Many of the recommendations that they had put forward were still under the consideration of the Government, and the agenda outlined by Mr. Meares contained abundant materials for discussion.

**Unipolar Induction.**—In the *Physical Review* for December, Prof. G. B. Pegram discussed the theory of unipolar induction in the light of the electron theory, and concluded that the E.M.F. was generated, not in the external conductor, but in the rotating magnet, the conductor merely completing the circuit. It appears that no E.M.F. is set up in stationary parts of the circuit.

**Trade Organisation Development.**—A conference which is to take place between trade representatives and Government representatives in the Saddlers' Hall, London, to-day, April 12th, will mark a new point in the process of trade organisation, to which the country is now giving so much attention. On behalf of the Government, three Ministries will be represented by their respective Ministers:—Dr. Addison, Minister of Reconstruction; Mr. G. H. Roberts, Minister of Labour, and Mr. Hayes Fisher, President of the Board of Trade. The trade immediately concerned on this occasion is the made-up leather goods and belting industry, and representatives both of employers and of employed will be present. The object of the meeting is to promote the formation, for this particular industry, of an "Interim Industrial Reconstruction Committee," and the movement is of interest to people of other trades, because this committee, it is hoped, will be the first of many similar committees, to be formed by such trades and industries of the country as cannot see their way clear to forming at once a full industrial council for their trade on the lines recommended in the First Whitley Report. The Interim Industrial Reconstruction Committee is to serve as a stepping-stone or half-way house to the full Industrial Council status. The First Whitley Report, it will be remembered, advocated a Joint Standing Industrial Council for each trade, but this recommendation was regarded as practicable only in such trades as had attained a considerable degree of industrial organisation as regards both employers and workers. Interim industrial reconstruction committees are now advocated for such industries and trades as have not attained so complete a degree of organisation, and also for more highly organised trades in cases where there are difficulties in the way of forming joint standing industrial councils. They are intended to fulfil temporarily some of the functions allotted to industrial councils, but they have also one added function of great importance, namely, to promote organisation both of employers and of employed in their industry, until each side has reached that degree of organisation which will admit of full industrial councils being formed. They are to give their attention also to other urgent problems which in the case of more fully organised industries will be dealt with by industrial councils. Among these problems are all the many trade difficulties embraced under the general head "demobilisation" and the re-absorption into industry of men from the various branches of national service at home and abroad; also the problems that will arise from the shortage of raw materials and the general shortness of money. They will be asked to consider also such questions as new industries, the proper disposal of Government surplus stores, and other questions affecting the general welfare and prosperity of their industries. But the great function of interim industrial reconstruction committees will be to bring about, each within its own industry, that degree of organisation, both on the part of the employers and on the part of the workers, and jointly on behalf of both, which will make possible the establishment for that trade of a full industrial council which can speak for its trade with one voice, act for it with the unanimous support of all its members, and represent it in the councils of the nation.

**The Formation of Diamonds.**—For the past 30 years, unknown to the scientific and engineering world in which, as the inventor of the steam turbine and other devices, he is so famous, the Hon. Sir Charles Parsons has been conducting experiments on the formation of the diamond. The results of his work in this fascinating field of research—work which has a direct bearing on many branches of pure and applied science—are to be made known for the first time at the eighth annual May Lecture, which he is to give before the Institute of Metals on May 2nd.

In view of the special character of the occasion, the Council of the Institute has decided to make this an open meeting. Those desiring to be present should apply—enclosing a stamped and addressed envelope—for cards of invitation to Mr. G. Shaw Scott, M.Sc., 36, Victoria Street, S.W. 1, who will also be glad to supply particulars of membership of the Institute, a ballot for election to which is due to be held on April 24th.

**Manchester Electricity Works and the 12½ per Cent. Bonus.**—Mr. J. Cunningham, secretary of the Shops Committee of Manchester Corporation electricity generating stations, states that an application will be made for a 12½ per cent. bonus, to apply to all workmen on munitions, directly or indirectly, or on auxiliary work.

The application was to be heard by the Government Committee on Production in London yesterday, and affects all Corporation and private electricity undertakings throughout the country and the building trades in general.

**National Kitchens.**—Of three national kitchens to be established in Hackney, one is to be fitted for operation with gas and two for operation with electricity. The Electricity Committee is to provide the electric cooking apparatus at the same price as the apparatus in the gas kitchen, and will maintain the two electric kitchens at the same price per kitchen as the gas kitchen. The Electricity Committee will further supply fuel and electrical energy to the electric kitchens at the same price per portion served as the cost of fuel per portion served in the gas kitchen.

**Whitley Committees.**—The *Times* states that a scheme has been formulated for the establishment of a Joint Industrial Council for the chemical trade on the lines of the recommendations of the Whitley Report. The Ministry of Reconstruction, which is taking an active interest in the project, has invited the Association of British Chemical Manufacturers to appoint representatives to serve on an "interim" Industrial Council.

**Fatalities.**—On March 27th an inquest was held concerning the death of James Hall (16), a Manchester Grammar School boy, who met with a fatal accident at the L. & Y. Railway Co.'s works, Newton Heath. Evidence showed that deceased, with about 40 other boys, went to the works on Saturday, March 23rd. They were instructed to go to a cabin near by and to have a wash. Along with two other boys, deceased went to the traverser's shed. They had no business there. A witness named Cummings said he put on the main switch, and when they had jumped on the traverser Hall set it in motion, and they rode up and down once or twice. Suddenly the machine stopped, and witness saw Hall lying down. He thought he must have had an electric shock, but found his arms had got caught. They had ridden on the traverser many a time. Mr. R. G. M'Laughlin, the works manager, said the traverser was electrically driven and was being repaired, and the guards for the time being had been taken off. A. E. Wilson said he found deceased's right arm pinned to the cog-wheel. He died on Sunday. The jury returned a verdict of "Accidental death," and expressed the view that some charge hand or responsible person should be in charge of the boys until they were off the premises.

At Barrow-in-Furness, on Tuesday, the Coroner of Furness concluded an inquiry into the death of Jane Mill Jones, a sweeper-up at the Naval Construction Works, which occurred in hospital on March 28th, as the result of burns sustained through an explosion at an electric motor, which ignited her clothing. John Worlsey, tool setter, said he saw the deceased near the motor, which was on the ground, and she had a shovel in her right hand, which she was pulling behind her. The shovel, he thought, must have caught the wire to the motor, because there was an explosion, and the woman was enveloped in flames. She was removed to hospital. James Ferguson, charge hand electrician, said that on hearing of the affair, he at once went to the place, and, on examining the electric motor, found that undue pressure had been placed on one of the leads which came through a pipe through the ground. It had been wrenched from its terminal, as there was evidence of burning on the motor casing. The explosion was a flash to earth caused by the short-circuit, which was made by the terminal wire touching earth; the flash would set fire to anything of a combustible nature, and would account for the deceased's clothing becoming ignited. In reply to a question, Mr. H. Clarke, H.M. Inspector of Factories, said he had seen the motor, and would say that it was reasonably safe. They did not know, however, how the wire was connected with the terminal, whether by an eye or a hook. If it had been connected with an eye it would have been impossible to pull it off the terminal. The wire had been pulled away. The jury returned a verdict: "That the deceased accidentally had her clothing set on fire by an explosion caused by the severance of the line at one of the motors, and died from the burns received."

An electrician named John Hexham (48), of Barrow, went into the storeroom of a floating dock to disconnect some wires in a junction-box. This box was 8 ft. from the ground, and, apparently, he would stand on a plank 4 ft. from the ground. After some time he was found on the floor, having apparently fallen from the plank. He died the same day. Verdict: "Accidental death."

**Volunteer Notes.**—London Army Troops Companies, Volunteer Engineers.—Headquarters: Balderton Street, Grosvenor Square, W. 1.

Orders for the week ending April 20th, 1918, by Lieut.-Colonel C. B. Clay, V.D., Commanding.

*Captain of the Week.*—Capt. E. G. Fleming.

*Next for Duty.*—Capt. W. Hynes.

Monday, April 15th.—No. 3 Company, 6.30—8.30. Recruits' Drill, 6.30—8.30. Signalling Section, 6.30—8.30.

Tuesday, April 16th.—Lecture on "Demolitions," 6.30. Physical Drill and Bayonet Fighting, 7.30.

Wednesday, April 17th.—No. 1 Company, Entrenchments, &c., 6.30. Recruits' Drill, 6.30.

Thursday, April 18th.—No. 2 Company, Entrenchments, &c., 6—8. Recruits' Drill, 6.30—8.30. Signalling Section, 6.30—8.30. Ambulance Section, 6.30—8.30.

Friday, April 19th.—Musketry, 5.30—8.

Saturday, April 20th.—Commandant's Parade, 2.45, for drill in Hyde Park. Drill Order, with rifles.

*Special Notices.*—All drills will be held at Headquarters unless otherwise stated.

(By order) Macleod Yearsley, *Capt. and Adjutant.*

Warwickshire Volunteer Engineers.—Warwickshire Engineers (Volunteers) were in training in camp for Easter at Chadwick Manor, Knowle, under the command of Major D. Shanks. The syllabus of training was prepared by Capt. and Adjutant S. T. Pemberton, and his efforts to make the camp a success were ably seconded by Capt. E. J. Jenkins, Lieut. G. O. Donovan, and Second Lieut. W. H. Varnom. The camp was formed on Thursday, March 26th. On Friday air line and cable sections were at work; on Saturday Col. D. F. Lewis, C.B., Commanding Officer of the Warwickshire Volunteer Regiment, inspected the men and their work. The Colonel expressed his satisfaction at the soldierly manner in which the officers and men paraded. A concert was held on Saturday, presided over by the Commanding Officer. On Sunday the Engineers attended Church Parade at Knowle Church, and on Easter Monday the camp was early astir and all sections at technical work. The motor air line section, under Lieut. H. Varnom, ran out wires on poles, as per schedule arranged, to buzzer instrument stations, and the cable section, under Capt. E. Jenkins, ran out similar telephone lines to field telephone stations. The technical work was carried out in a creditable manner, and the officers, non-coms., and men were complimented by the C.O. on their accomplishment. The afternoon was devoted to sports, and in the evening another concert was held. On Tuesday the morning was devoted to loading wagons and clearing up, and the Engineers and equipment returned to headquarters, Thoro Street Barracks, Birmingham, on Tuesday afternoon. In addressing the officers, non.-com. officers and sappers, Major Shanks complimented all on their work. He specially praised the excellent work of the Adjutant, Capt. S. T. Pemberton, to whom was allotted the task of organising the camp and making all arrangements for the training and comfort of the men. Lieut. G. O. Donovan acted throughout the camp as orderly officer, and had the whole camp under firm, but kindly, control from start to finish. Capt. Jenkins and Lieut. Varnom both carried out their duties in an efficient manner, and the sappers benefited greatly by the training they received under these capable officers.—*Birmingham News.*

**Appointments Vacant.**—Mains assistant for Sunderland Corporation (£225); junior shift engineer for Gravesend Corporation (55s.); shift engineer for Farnworth (60s. + 12½ per cent.); fitter and general station hand (£250) for the Electric Light Station at Lagos, Nigeria; cable jointer (1s. 4d. an hour) for the Eccles Corporation Electricity Department; charge engineer for the Dover Corporation Electricity Department; assistant shift engineer (70s.) for the Battersea Corporation Electricity Works. See our advertisement pages to-day.

**Dr. Ferranti's Cotton-spinning Patent.**—On Wednesday last, Mr. Justice Sargant, in the Chancery Division, concluded the hearing of a petition by Dr. S. Z. de Ferranti and Messrs. Coates, cotton spinners, of Paisley, for an extension of Letters Patent granted to Dr. Ferranti in 1903 for an invention relating to spinning, twisting, and doubling machinery. There was no opposition, and his Lordship, in the result, reserved his formal judgment, but said he was disposed to grant an extension for seven years.

**Patents and Alien Enemies.**—The Board of Trade has granted licences in respect of 23 patents issued to the firm of R. Bosch and others, dating from 1908 to 1913, to the British Lighting and Ignition Co., Ltd., and the Public Trustee has granted a licence to the same company in respect of Patent No. 10,380/14, issued to R. Bosch.

**The I.E.E. Wiring Rules.**—The Council has adopted a recommendation of the Wiring Rules Committee that Wiring Rule No. 62 shall not apply to consumers' electric supply meters for currents up to 100 amperes, made in accordance with the Engineering Standards Committee's Specification No. 37. The rule referred to relates to the method of connecting conductors larger than 7/18 S.W.G. to the terminals of the meter, requiring the use of cable thimbles.

**Production of Home Fuel Oil.**—The Minister of Munitions, in agreement with the Secretary for the Colonies and the Petroleum Executive, has appointed a Committee to inquire into certain matters relating to fuel oil, with the Marquis of Crewe as chairman. The Committee will consider the report which has been rendered by the Petroleum Research Department on the production of fuel oil from home sources.

**The Fixation of Atmospheric Nitrogen.**—In the *Zeitschrift des Vereines Deutscher Ingenieure* H. Andriessens describes an arrangement working on the same principle as the Birkeland furnace for obtaining nitrogen from the direct combustion of air, and for which 80 per cent. higher output is claimed. The Birkeland furnace is based on the assumption that a maximum yield of fixed nitrogen is obtained by spreading out the arc so as to obtain a maximum reaction surface. The Andriessens furnace, on the other hand, aims at obtaining maximum linear extension of the arc and minimum surface of the flame volume, on the ground that the reaction velocity between nitrogen and oxygen is extraordinarily high, so that the sooner the products can be removed from the flame zone the less the extent to which dissociation will occur. The nitric oxide should be cooled down in the shortest possible time, and previous methods do not take account of this condition. The arc should be lengthened as much as possible, and its surface kept as small as possible. To effect this, an air blast is delivered between two vertical rod electrodes set below but in the same vertical plane as the line joining the poles of a powerful electromagnet. The net result of air blast and magnetic field is to spread the arc over a surface limited by a helix which may have a pitch of only a few mm. The air velocity may be four times that usual in the Birkeland furnace. From a 35-KW. furnace the yield may be 70 gm. (referred to 100 per cent. nitric acid) as compared with 30 to 45 gm. from a Birkeland furnace of equal power.

The *Norsk Hydro-Elektrisk Kvaelstofaktieselskab*, Christiania, denies that the Andriessens method is so much superior to the Birkeland method, and states that the output of furnaces of the latter type is considerably higher than is stated by Andriessens; the latter replies that his results incorporate the experience of eight years' work, and that no authoritative figures have ever been given of the performance of the Birkeland furnace.

## OUR PERSONAL COLUMN.

*The Editors invite electrical engineers, whether connected with the technical or the commercial side of the profession and industry, also electric tramway and railway officials, to keep readers of the* ELECTRICAL REVIEW *posted as to their movements.*

**Central Station and Tramway Officials.**—At a meeting of the Belfast Corporation last week, Coun. Sir Crawford M'Cullough drew attention to the fact that the tramway manager, Mr. J. S. D. MOFFATT, had been recommended for the appointment of deputy manager of the Liverpool Corporation's tramways, and that the Council in committee, with a view to retaining his services, recommended that his maximum salary be fixed at £1,200, to be reached by annual increments of £100 in September, 1918, £100 in September, 1919 and 1920, and £50 in 1921. He understood that Mr. Moffatt would accept those terms. The recommendation was unanimously adopted.

The Bath Electricity Committee has increased the salary of Mr. A. R. SHAPLEY, deputy electrical engineer, from £275 to £325 per annum.

Worthing Corporation Electricity Committee has increased the salary of Mr. H. A. BEST, the assistant electrical engineer, from £175 per annum to £195, with two further £10 increments to a maximum of £215.

Mr. PERCY PRIESTLEY, general manager of the Oldham Corporation tramways, has been appointed deputy manager of the Liverpool Corporation tramways, subject to the approval of the City Council, at £800 per annum.

The Bexhill-on-Sea T.C. has increased the salary of the chief assistant electrical engineer to £175 a year.

Mr. J. MAKIN, electrical mains superintendent of the northern district at Stoke-on-Trent, on leaving to become deputy electrical engineer and tramways manager at Bexley Heath, has been presented by the staff and townsmen with an illuminated address and a gold watch.

Eastbourne Electricity Committee has recommended the payment of an honorarium of £50 to the electrical engineer, in recognition of extra work caused by the shortage of staff.

Doncaster Electricity and Tramways Committee has recommended that the salary of Mr. T. POTTS, acting traffic manager, be advanced from £206 to £250 a year.

Birkenhead Tramways Committee has recommended the T.C. to increase the salary of Mr. C. CLARKE, tramway manager, from £450 to £500 a year, with annual increments of £50 to £650.

Mr. C. J. SPENCER, the Bradford tramway manager, has been released by the Admiralty, in response to urgent pressure from the city that he might be allowed to take up his old duties. The Admiralty write that they part with Mr. Spencer with great reluctance, and convey their thanks to the tramway department and the Council for the loan of that official to be Assistant Director (Labour Division) of the Shipyard Labour Department. The Admiralty hope to utilise the advice and experience of Mr. Spencer on a future occasion.

Mr. JAMES HAMILTON, son of Mr. J. B. Hamilton, the general manager of the Leeds Corporation tramways, has been appointed in charge of the new parcel-carrying scheme in connection with the Leeds tramways.

Northampton T.C. has increased the salary of the tramway manager from £350 to £400 a year.

The York Electricity and Tramways Committee recommends the City Council that the offices of city electrical engineer and tramway manager be amalgamated at an inclusive salary, and that the salary of the engineer and tramway manager, Mr. J. W. HAME, be increased from £550 by £100, with further annual increments of £50 to a maximum of £800, such increase to cover the 12½ per cent. advance under the Askwith award, if held to be payable.

**General.**—Mr. C. W. CROSBIE has resigned his position with Messrs. Ferranti, Ltd., on his appointment as an electrical engineer under the Air Ministry.

Captain J. YOUNG has been transferred to the Indian Army and appointed Deputy Assistant Director of Military Works at Army Headquarters, India. He was formerly lieutenant in the Highland Light Infantry, and, in civil life, electrical engineer with the Scottish Boiler Insurance and Engine Inspection Co., Ltd., Glasgow.

Mr. F. K. COOKE, F.C.I.S., late secretary with the Unbreakable Pulley & Millgearing Co., Ltd., and the Cooper Roller Bearings Co., London and Manchester, has been appointed secretary to John Wood & Sons, Ltd., of Barley Brook Foundry and Engineering Works, Wigan.

Mr. JOSEPH RIPPON, of the Bermuda Cable Companies, and chairman of the Bermuda Contingent Committee, has been awarded the O.B.E. for services in or for the Overseas Dominions, Colonies, and Protectorates in connection with the war.

Dr. J. ERSKINE-MURRAY, who is now engaged in Government service, has retired from the firm of Messrs. Clark, Forde, Taylor & Erskine-Murray, and Mr. A. L. Dearlove will be joined by Mr. E. S. Heurtley as a partner in the firm, which will revert to the old style of Messrs. Clark, Forde and Taylor. Mr. Heurtley is a member of the Institution of Electrical Engineers, and is well known in the cable world as the inventor of the Heurtley magnifier relay, and other important inventions in connection with submarine cables. We wish Mr. Dearlove and his partner the success which attended the old firm (friends of our youthful days) through so many long years of activity.

**Roll of Honour.**—The *Times* records that Lieutenant G. K. STEINBERG, M.C., M.G.C., who was killed on March 22nd, aged 25, was educated at University College School, and on leaving entered the patents department of the British Thomson-Houston Co., Ltd.

The death in action is announced of Second-Lieutenant E. T. WILSON, Royal Warwicks, of the B.T.H. Co., Rugby.

The death in action is reported of Sergeant B. GILL, West Yorkshire Regiment, and formerly with Messrs. Ingleby and Co., Ltd., manufacturing electrical engineers, Leeds.

Captain GEORGE VALLANCE ROWBOTTOM, M.C., Oxford and Bucks. L.I., reported missing since March 21st, was prior to enlisting in the R.N.D. an electrical engineer at Oxford.

Sergeant J. YATES, R.G.A., who has been awarded the Belgian Croix de Guerre, was formerly a motorman on the Burnley Corporation tramways.

Sapper B. ARMSTRONG, of Seedley, Manchester, killed on March 29th, was formerly employed at the British Westinghouse Co.'s Works, Trafford Park.

Private A. C. ENTWISTLE, Manchester Regiment, who has died of wounds, was employed in the Manchester Corporation electricity department at the Town Hall.

Sapper H. HANDLEY, R.E., who has died of wounds, was employed by Messrs. Electromotors, Ltd., Manchester.

Private J. A. J. WAINER, Manchester Regiment, seriously wounded, was employed by Messrs. Royce, Ltd., Trafford Park.

Second-Lieutenant R. P. SHAW, formerly an electrician with the Rochdale Electric Co., has been killed in action, aged 24 years.

Captain and Adjutant HAROLD SMITH, formerly chief assistant to the Leeds tramways traffic superintendent, has died from wounds.

Second-Lieutenant A. D. MOORE, Essex Regiment, formerly in the employ of the India-Rubber Co., Silvertown, was killed on 23rd ult. Corporal J. H. FLETT, Royal Fusiliers, of the same company, has been wounded and missing since November 30th last. Sergeant A. H. TAYLOR, R.F.A., who was in the waterproofing department of the India-Rubber Co., was gassed in France in March. Private W. L. JACKSON, Middlesex Regiment, formerly in the cashier and buyer's office of the India-Rubber Co., is now a prisoner of war.

**Obituary.**—MR. ROBERT WINTHROP BLACKWELL, M.I.E.E.—By the sudden death of Mr. Robert W. Blackwell, after a very short illness, at his residence, "Elmbank," Hampstead, on March 28th, the electrical profession loses one of the few remaining and best known pioneers of electric traction, and one whose name has been intimately connected with this most important branch of electrical engineering, both in the United States and in this country, for the last 35 years. Born in 1858, Mr. Robert W. Blackwell graduated as M.A. and B.L.L. at Princeton University, where he was a contemporary of President Wilson, and afterwards practised as a Councillor of Law at the American bar. Attracted, however, by the great demand for mechanically-operated street cars, the need for which was so urgently felt in the United States, he jointly with Mr. Edward W. Bentley and Mr. Walter H. Knight, founded in 1883 the Bentley-Knight Electric Railway Co., of New York, which installed and equipped an electrically-operated tramway system in Cleveland, Ohio, opened for traffic in 1884, and which was the first line to be operated electrically as a commercial undertaking. Mr. Blackwell, as a contemporary of Sprague, Vanderpoel, and Edison, was intimately associated with the great pioneer work carried out in the U.S.A. between 1883 and 1889. He was actively engaged with the management of his company until, in 1889, he transferred the Bentley-Knight Co.'s interests to the Thomson-Houston Co., of Lynn, Mass. Mr. Blackwell was shortly afterwards summoned to England to give evidence before Parliament on behalf of the first Bill promoted by the Central London Railway Co., and it was the experience he gained during this stay which showed him the great prospects of electric traction in the United Kingdom, and which eventually, in 1890, induced him to take up his residence in this country. In 1890 he became associated with Messrs. Greenwood & Batley, of Leeds, in conjunction with whom he opened an office in London for the purpose of introducing electric traction on the tramway systems in the United Kingdom. In 1894 Mr. Blackwell founded the firm of Robert W. Blackwell & Co., which, ever since that time, has been well known as one of the leading firms of merchants, manufacturers, engineers, and contractors. In 1895 Messrs. Blackwell secured the contract from the British Thomson-Houston Co. for the construction and electrical equipment of a new tramway in Bristol, and the work they there carried out was so satisfactory that it at once secured their position as leading contractors in the electric traction field. The great financial success secured by this first electrification on a commercial scale served as an incentive to many others. As engineers and contractors, Messrs. R. W. Blackwell were henceforth connected with a very large number of the electric traction systems installed in this country. They supplied materials and engineering advice to a large number of continental firms,

and they were the expert advisers on traction matters to such firms as the Oerlikon Co., Schuckert & Co., and Ganz & Co., and their designs and specialities are to be found in a very large number of electric tramway installations throughout Europe, Africa, Asia, and South America. It was they who designed the originally successful trolley standards for top-seat tramcars, and who first standardised the pole and bracket arm construction for overhead lines. Wherever anything new was to be seen, or experience was to be gained, there Mr. Blackwell went, or sent his engineers or representatives, to investigate and test, with the result that purchasers always came to him for information and advice. He exhibited in 1897 at the Brussels Exhibition an exhibit which was one of the most interesting in the whole British section, and he was a member of the International Jury there. It is interesting to note that, although American born and a very prominent member of the American Society in London, all Mr. Blackwell's associates and staff were British. His firm carried out many important works for English railway companies, including the Great Western, the Great Central, and the London, Brighton & South Coast Railway Companies. The work carried out for the last-mentioned company includes some of the most difficult bits of construction ever put up, and was erected under the most unfavourable conditions. The work was carried out to the design, and under the supervision, of Mr. Philip Dawson, M.Inst.C.E., &c., the consulting electrical engineer of the L.B. & S.C. Railway Co., who for the

Robert Winthrop Blackwell.

first 15 years of Mr. Blackwell's activities in this country had been intimately associated with him. This line has now been in operation for over nine years, and, thanks to the observation of the principle always inculcated in his staff by Mr. Blackwell of never doing bad work, the results have fully justified the confidence placed in him by this company, and have falsified the many criticisms made against the adoption of the overhead system, as well as the prophecies as regards the high cost of maintenance, frequent failures, and interruption of service made from so many sides when the decision of the Brighton Co. to adopt the overhead system first became known. As founder and chairman of Robert W. Blackwell & Co., Ltd., his name is a household word among those connected with electric traction throughout the world. Not only as an engineer and contractor, but in many other directions Mr. Blackwell showed an initiative by building up a most successful roofing business, the material being made in his own works, by the manufacture in this country of apparatus and materials which had previously had to be imported from abroad, and by doing everything he could to encourage British enterprise. He was for many years chairman of Messrs. Johnson & Phillips, the well-known electrical engineers and cable manufacturers, and did very much to bring them to the high pitch of prosperity they have reached to-day, and he was as much loved and respected by his co-directors and the employés of this firm as he was by those of Messrs. Blackwell & Co. He had many outside interests. He was in charge of most of the arrangements for looking after the American Military Mission during their visit to this country, and he was a great supporter of the American Red Cross and kindred societies.

Mr. J. S. Brodie.—Mr. John S. Brodie, borough engineer of Blackpool, last year's President of the Institution of Municipal and County Engineers, passed away suddenly on Monday, aged 67 years.

**Will.**—The late Sir J. Wolfe Barry left £278,362, of which £225,033 is net personalty. Sir John left £250 to the Benevolent Fund of the Institution of Civil Engineers, and £200 to the Benevolent Fund of the Institution of Mechanical Engineers. On the death of his widow, a further £1,000 goes to the Benevolent Fund of the Institution of Civil Engineers.

## CITY NOTES.

**Kensington and Knightsbridge Electric Lighting Co., Ltd.**

Col. R. E. Crompton, presiding at the annual meeting, said that during 1914, 1915, and 1916 there had been a progressive falling off in their units sold, but his forecast of a year ago that the tide had turned in their favour had been confirmed to the extent of nearly half a million units. The increase in output, and the increased charge of 10 per cent. to certain of the units sold had increased the revenue by £10,500. The number of unoccupied houses in the district had slightly decreased. The total cost of generating had increased by £6,041, distribution costs had slightly advanced, and rates and taxes had largely increased. The larger revenue had enabled them to increase the amount put to depreciation; they hoped to put by still more when conditions were more favourable. They had also increased the dividend by 1 per cent., and the amount of the carry-forward. Fuel was obtained with difficulty, and its quality was poor. That increased labour charges, as larger quantities of coal had to be handled, and more ash was produced. The scarcity of materials for maintenance, and the practical impossibility of getting any repairs carried out at manufacturers' works, had entailed on them the whole duty of repairs; this had been done efficiently, but it certainly added to the expenses. Their supply for heating and cooking had considerably increased, owing probably to consumers finding difficulty in obtaining domestic coal, and deciding to install electric heating apparatus. This was a useful public service, as it caused reduction in the total consumption of fuel, which was very wasteful in domestic fireplaces. Partly due to this cause, the company's showroom and sale department had been very fully occupied, so that the sales had nearly doubled during the year. In fact, more orders had been received than they could carry out with their reduced staff, and 45 per cent. of the work had been handed over to local contractors. It would not be wise to expect much improvement, if any, during the present year. They would do very well if they kept up to the present mark of profit earning. Other difficulties were in prospect, and they felt it necessary to again increase the prices by 10 per cent., making the total advance on pre-war prices 20 per cent. This compared very favourably with the increase in the price of other commodities, and with the purchasing power of a sovereign as compared to peace time.

**Charing Cross, West End, and City Electricity Supply Co., Ltd.**

Mr. W. F. Fladgate, presiding at the annual meeting on March 21st, referred to the great difficulties of the year. Though the sale of energy had increased, the increase in expenses had been correspondingly greater. Coal, because of price increase and quality decrease, was a serious matter. At Bow station the cost of coal increased from £59,365 to £87,767. Dealing with the West End undertaking, sales of current had increased by £13,500, but the cost of fuel was higher by no less than £18,500, £1,500 for the internal-combustion engines, and £17,000 for the purchase of energy from the City undertaking. The increase in purchase was due to the difficulty in getting fuel for the West End plant, and in getting repairs done to enable them to use it. Every item of expenditure was increased, particularly wages, with the result that, though the total receipts were £15,000 more than for 1916, the expenditure increased by £25,000. In the case of the City undertaking, the receipts were £35,000 better, but practically every item of expenditure increased, and the balance carried to revenue account was the same as in 1916. During 1917 they had made no increase in the price of current, but a very considerable increase must now be made. In the City area they were handicapped by the provisions of the Order. It was obtained many years after the other London Orders, and at a time when the price of current had been much reduced. Their maximum was fixed at 5d., and at that time it was probably not an unreasonable figure. The effects of the war had shown that it was an extremely unfair one, but the Board of Trade had not, at present, seen their way to increase it. They hoped to be able to satisfy them of the unfairness of the position that one company out of all the London companies should be prevented from charging what was now only a reasonable price for the supply of electric current in one half of their area. The price of power was not so circumscribed, and consequently they would be able materially to increase it. They would probably in any case have had to increase their charges, but the 12½ per cent. rise of wages imposed by the Ministry of Munitions, added to the increase

of wages that they had already given, had made it imperative. Not only would that 12½ per cent. increase their labour bill, but indirectly it would increase the price of almost every material that they had to buy. Referring to the extreme disabilities under which they had been labouring, he said that it had often been a matter of anxiety to the board to know whether they could go on with the work, but by the help of the employés they had been able to carry on up to the present. One of the After-the-War Committees had reported upon the position of the electric light industry. No final report had yet been issued, but there had been interim reports, one in particular dealing with the coal supply. He asked them to postpone their judgment on these interim reports, and not to consider them too seriously. They were by no means unanimous—in fact, to some extent they were contradictory. Incidentally, the London companies were more or less blamed for not having supplied energy at a cheaper rate, and so made it more available for general use. He again protested against this charge, as he believed it to be unfair. Whatever might be decided as regards other districts, the London area should be dealt with as an individual one. He had personally endeavoured for many years to bring about an amalgamation of the London companies, as he believed that they were fully competent, under proper conditions, to carry out the whole work for the London area, and would no so better and more economically than any other possible combination. If the Board of Trade had sanctioned the companies' Bill promoted in 1908, they would have been able to deal successfully with the whole of the London district. He believed that an amalgamation of the London companies would be for their benefit, and for the benefit of the L.C.C., who had the ultimate right of purchase. In the midst of war it was unwise to say anything as to the future. The electric lighting industry was perhaps less immune from consequent troubles than most other industries. Depending as they did largely upon coal supply, the work of the enemy submarine had been a very serious menace to their prosperity, even to their very existence.

**W. T. Henley's Telegraph Works Co., Ltd.**

For the year 1917 the profits were £238,725, from which are deducted debenture interest and depreciation, &c., £75,857, leaving £162,867, plus £69,730 brought forward, making £232,597. There is transferred to reserve for depreciation of trustee securities £2,801, to reserve £25,000, to special war allowances reserve £5,000. After paying the preference dividend, the ordinary shares receive 15 per cent. and a bonus of 10s. per share, less tax, leaving £112,042 to carry forward.

Payment has been made to the Inland Revenue of the amount of Excess Profits Duty due to the end of the year 1916, and provision has been made in the accounts in respect of the liability for the year 1917.

Provision has again been made for special depreciation on the machinery in the factories which has been running day and night on Government work, and for machinery which has been bought specially for war purposes which will be useless, or of problematical value, after the war.

The income-tax is charged to the profit and loss general account, instead of to the profit and loss account, as was the case in previous years. This has been done at the desire of the auditors, and should be noted in making a comparison of the balance carried to profit and loss general account with previous years.

It is proposed to sub-divide the £5 ordinary shares of the company into shares of £1 each, and to form a Tire Co., having a share capital of £200,000, the whole of which will be held by the company, also to increase the ordinary share capital of the company by £200,000, and to distribute that amount in fully-paid shares as a bonus amongst the ordinary shareholders. The consent of H.M. Treasury has been obtained to the issue of the £200,000 ordinary shares, but authority to issue shares of the Tire Co. has not yet been received.

After the business of the annual meeting (April 19th) has been disposed of the special resolutions respecting capitalisation of the reserve and the formation of a Tire Co. will be submitted.

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**W. T. Glover & Co., Ltd.**—The result of trading in 1917 is a credit balance of £40,439, plus £22,025 brought forward. After meeting the interest on the 4½ per cent. first and 5 per cent. second mortgage debenture stock, and paying £5,786 for excess profits 1915 and 1916, £4,000 is transferred to the trustees of the second mortgage debenture stock, 5 per cent. is paid on the preference shares, less income-tax, £2,500 is transferred to first mortgage debenture redemption fund, a dividend of 5 per cent. and a bonus of 2½ per cent., less tax, are to be paid on the ordinary shares, £20,000 is put to reserve fund, and £10,770 is carried forward, subject to Excess Profits Duty. The redemption fund for the first mortgage debenture stock will now stand at £45,500, that for the second mortgage ditto at £44,725, and the reserve fund at £80,000, making a total of £170,225.

**Folkestone Electricity Supply Co., Ltd.**—Notwithstanding the adverse conditions of 1917, the profits are satisfactory. The equivalent of 7,376 8-c.p. lamps were added. The price to consumers was advanced, but the increased revenue has not compensated for the additional expenditure on fuel and labour. The profit from the three undertakings (Folkestone, Sandgate, and Hythe) were £14,633. Dividend on the ordinary shares, 7 per cent. for the year; £4,262 to depreciation fund; £1,000 to reserve; £2,643 carried forward.

**Willans & Robinson, Ltd.**—According to the "Financial Times" the directors of this company, after consultation with the board of Dick, Kerr & Co., which now holds the majority of the shares in the company, propose to modify the arrangement with the "B" preference stockholders.

**Dublin & Lucan Electric Railway Co.**—Out of the available balance of £604 for 1917, the preference dividend is to be paid for one half-year, absorbing £475, leaving £129 to be carried forward. At the meeting of the company, Mr. J. W. Hill, who presided, said that under the coal conservation scheme the Government had ordered a very considerable reduction in all railway services, and in the case of this company it would necessitate a reduction of 25 per cent. in the existing reduced service, such reduction taking effect on April 25th.

**Launceston & District Electric Supply Co., Ltd.**—During 1917 the revenue receipts were £1,073, against £1,102 in 1916, and the working expenses were £620. Consumers increased from 227 to 246, and lamps connected from 6,413 to 7,698. Motors connected now number 16, with a total of 48 h.p. Gross profit £453. After deducting bank charges and preference dividend, paying 2 per cent. on the ordinary shares, putting £135 to depreciation, writing £50 off preliminary expenses, and putting £25 to reserve, £25 is carried forward.

**American Telephone & Telegraph Co.**—The report for 1917 states that net earnings were $48,940,466, or $4,197,090 more, after providing for Federal income and excess profits taxes payable in 1918. Interest charges were $10,469,360, and dividends at the regular rate of 8 per cent. per annum $32,481,613. Of the resulting balance there were carried to reserves $2,500,000, and to surplus $3,489,492.—*Financial Times.*

**British Westinghouse Electric & Manufacturing Co., Ltd.**—The directors recommend a dividend of 7½ per cent. on the preference shares for the year ending December 31st last.

**Consolidated Electrical Co., Ltd.**—Dividend, 2½ per cent. on the ordinary shares, leaving £2,947.

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## STOCKS AND SHARES.

Tuesday Evening.

The news from the Western Front continues to be the predominant factor in Stock Exchange markets. Besides this, however, there are two others of nearly as great interest in the City, to wit, the Man-Power Bill and the forthcoming Budget. Details of the former will have been published before this article, and therefore the immediate effect upon Stock Exchange prices can only be surmised. In advance, members of the House were disposed to think, having regard to the prophecies so freely made, that business in securities would be considerably affected, and that if a large number of men between the ages of 41 and 50 were called up, the influence upon prices would be to cause a decline in the latter.

Besides this, there is the looming ahead of the Budget, with its probable fresh taxation. Any addition to the income-tax, for instance, usually results in the prices of fixed-interest stocks giving way, inasmuch as the holders of such securities are tempted to sell them in order to reinvest the money in something else, though it should be more speculative, that will bring them in a corresponding rate of income, allowing for the extra addition of tax. This consideration is, of course, emphasised at the present time by the increase in costs of living. All things considered, the outlook for investment is somewhat nebulous, though experience goes to show that investors and capitalists take a surprisingly short time to settle down to new conditions when these are imposed.

The majority of movements in prices during the past week have been in the downward direction, although a fall has made no great progress in any market. At the root of the matter, there lies, of course, the natural disinclination on the part of anybody with money to utilise it in Stock Exchange channels until more light has been shed upon the situation, both financial and military. Yet it is curious to notice that there is still a shortage of shares in various directions, and of these, the most apt illustration which has come under our notice is the fact that a purchase of no more than 12 shares in a well-known cable company had the effect of putting up the price by 5s. The cable market on the whole is, however, leaning to the duller side, and small falls have occurred in Anglo-American Deferred, Eastern Extensions, Oriental Telephones, and United River Plate Telephones. The strength of the manufacturing group is well held, and the slight apprehension felt in regard to the possibility of the Treasury prohibiting new share issues is but little apparent.

Marconis have fallen back to 3⅛, and the recent buyers who gave up to 70s. for the shares on the issue of the company's law suit with the Government are probably regretting their hastiness. The subsidiaries are steady, though Marines have eased off a trifle to 2⅛.

Mexican Utilities are dull. There are small falls in the shares and bonds of the Mexico Tramways Co., and this in spite of the encouraging reports which are reaching this side in regard to the present position of affairs in the Republic. A report will be published at the end of this month on the investigations of two well-known New York bankers who have been studying the current problem at first hand in Mexico city. This should result in recommendations which are likely to be acted upon by the authorities in Mexico. The Monterey Light and Power Committee published the other day an account of its stewardship to date, and from this it is evident that Mexicans are not unwilling to do what they

can to restore the credit of their country by fair and honest treatment of the utility corporations, and others of similar character. So far as the Stock Exchange is concerned, however, the various testimonies borne to the better condition of affairs which is emerging in Mexico have been entirely without effect, for prices have given way in the various markets of stocks and shares connected with the Republic.

General Electric ordinary shares have risen to 20¼, but apart from this the tendency in the manufacturing group is towards rather lower levels. India-Rubbers went back to 15½, and Westinghouse Preference to 2 11/16. On the other hand, Babcocks are up to 3 5/16, and there has been some trifling inquiry for a few of the debenture stocks, with the result that prices stiffened to the extent of a point or so. Edison Preference have eased off to a guinea, shares changing hands at 20s. 6d. to-day, Tuesday.

In the electricity supply list, Westminsters are ½ down at 6¼, and this is the only movement amongst the London shares. Incidentally, it is interesting to notice from the report of the Stock Exchange just out that it cost the House £1,371 9s. 5d. for electric power, working expenses, and maintenance in respect of the year just finished, this showing a reduction of about £70 as compared with the previous 12 months. The electric railway market is heavy, Districts receding to 14, and Underground Incomes to 77½, the reason being the lack of vitality or resiliency in markets generally. The same want of spring is noticeable in rubber, armament, and other industrial sections, while the only notable activity amongst mining shares has been in a few Cornish issues that have suddenly become popular.

## SHARE LIST OF ELECTRICAL COMPANIES

### Home Electricity Companies.

| | Dividend 1916. | Dividend 1917. | Price April 9, 1918. | Rise or fall this week. | Yield p.c. |
|---|---|---|---|---|---|
| Brompton Ordinary | 9 | 10 | 6⅞ | — | £7 8 0 |
| Charing Cross Ordinary | 5 | 4 | 3½ | — | 5 14 4 |
| do. do. do. 4½ Pref. | 4½ | 4½ | 2½ | — | 6 18 6 |
| Chelsea | 3 | 3 | 3 | — | 5 4 4 |
| City of London | 8 | 8 | 12⅜ | — | 6 9 3 |
| do. do. 6 per cent. Pref. | 6 | 6 | 9½ | — | 6 0 4 |
| County of London | 7 | 7 | 16⅜ | — | 6 11 0 |
| do. 6 per cent. Pref. | 6 | 6 | 9½ | — | 6 0 4 |
| Kensington Ordinary | 6 | 7 | 8⅞xd | — | 6 10 3 |
| London Electric | Nil | Nil | 1½ | — | Nil |
| do. do. 6 per cent. Pref. | 4 | 5 | 3½ | — | 8 0 0 |
| Metropolitan | 3 | 4 | 3⅝ | — | 5 18 6 |
| do. 4½ per cent. Pref. | 4½ | 4½ | 3½ | — | 6 13 4 |
| St. James' and Pall Mall | 8 | 9 | 7½ | — | 6 6 4 |
| South London | 5 | 5 | 3⅞ | — | 7 2 4 |
| South Metropolitan Pref. | 7 | 7 | 21/- | — | 6 13 4 |
| Westminster Ordinary | 7 | 9 | 6¼ | — ½ | 7 2 10 |

### Telegraphs and Telephones.

| | Dividend 1915. | Dividend 1916. | | | |
|---|---|---|---|---|---|
| Anglo-Am. Tel. Pref. | 9 | 9 | 9½ | — | 6 7 0 |
| do. Def. | 23/6 | 1½ | 12⅜ | — ½ | 6 14 10 |
| Chile Telephone | 8 | 8 | 7⅞ | — | 5 8 4 |
| Cuba Sub. Ord. | 6 | 7 | 9½ | + ½ | *7 7 4 |
| Eastern Extension | 8 | 8 | 16⅜ | — | *5 5 0 |
| Eastern Tel. Ord. | 8 | 8 | 15¾ | — | *5 4 6 |
| Globe Tel. and T. Ord. | 7 | 7 | 14⅜ | — | *4 18 3 |
| do. Pref. | 6 | 6 | 10 | — | 6 0 0 |
| Great Northern Tel. | 22 | 24 | 36 | — | 6 11 6 |
| Indo-European | 13 | 13 | 6½ | — | 6 6 8 |
| Marconi | 10 | 15 | 8½ | — ½ | 4 16 0 |
| Oriental Telephone Ord. | 10 | 10 | 6¼ | — ⅛ | 3 8 7 |
| United R. Plate Tel. | 8 | 8 | 7⅞ | — ⅛ | *5 17 8 |
| West India and Pan. | 6d. | 6d. | 1⅝ | — | *3 17 0 |
| Western Telegraph | 7 | 8 | 16⅛xd | — | *5 5 0 |

### Home Rails.

| | | | | | |
|---|---|---|---|---|---|
| Central London, Ord. Assented | 4 | 4 | 6¼ | — | 6 10 7 |
| Metropolitan | 1 | 1 | 30½ | — | 4 17 7 |
| do. District | Nil | Nil | 14 | — ½ | Nil |
| Underground Electric Ordinary | Nil | Nil | 1½ | — | Nil |
| do. do. "A" | Nil | Nil | 8/- | — | Nil |
| do. do. Income | 3 | 4 | 77½ | — ½ | *5 3 3 |

### Foreign Trams, &c.

| | Dividend 1915. | Dividend 1916. | | | |
|---|---|---|---|---|---|
| Adelaide Sup. 6 per cent. Pref. | 6 | 6 | 4⅜ | — | 6 3 1 |
| Anglo-Arg. Trams, First Pref. | 6½ | 6½ | 2⅜ | — | — |
| do. 2nd Pref. | 6½ | — | 2⅛ | — | — |
| do. 5 Deb. | 5 | 5 | 6⅜ | — | 7 11 0 |
| Brasil Tractions | 4 | 4 | 4⅜ | — | — |
| Bombay Electric Pref. | 6 | 6 | 9¼ | — | 6 6 4 |
| British Columbia Elec. Ry. Pfce. | 5 | 5 | 52½ | — | 9 12 4 |
| do. do. Preferred | Nil | Nil | 32½ | — | Nil |
| do. do. Deferred | Nil | Nil | 27⅛ | — | Nil |
| do. do. Deb. | 4½ | 4½ | 5⅜ | — | 7 6 7 |
| Mexico Trams 5 per cent. Bonds | Nil | Nil | 33 | —1 | Nil |
| do. 6 per cent. Bonds | Nil | Nil | 83½ | — | Nil |
| Mexican Light Common | Nil | Nil | 17⅝ | — | Nil |
| do. Pref. | Nil | Nil | 29 | — | Nil |
| do. 1st Bonds | Nil | Nil | 86½ | — | — |

### Manufacturing Companies.

| | | | | | |
|---|---|---|---|---|---|
| Babcock & Wilcox | 15 | 15 | 3⅛ | + 1/16 | 4 16 4 |
| British Aluminium Ord. | 7 | 10 | 3/- | — | 6 5 0 |
| British Insulated Ord. | 17½ | 20 | 9⅜ | — | 5 10 4 |
| British Westinghouse Pref. | 7½ | 7½ | 2⅞ | — ¼ | 5 11 7 |
| Callenders | 20 | 20 | 17⅜ | — | 5 15 4 |
| do. 5 Pref. | 5 | 5 | 4 | — | 6 5 0 |
| Casmer-Kellner | 23 | 20 | 8½ | — 1/16 | 5 14 2 |
| Edison Swan, fully paid | — | — | 2⅛ | — | Nil |
| do. 4 per cent. Deb. | 4 | 4 | 75½ | — | 5 6 0 |
| Electric Construction | 7½ | 7½ | 1⅝ | — | 6 6 4 |
| Gen. Elec. Pref. | 5 | 5 | 10⅜ | — | 5 15 8 |
| do. Ord. | 10 | 10 | 20⅜ | + ¼ | 4 18 9 |
| Henley | 25 | 25 | 19½ | — | 6 8 2 |
| do. 4½ Pref. | 4½ | 4½ | 3⅜ | — | 5 12 2 |
| India-Rubber | 10 | 12 | 15½ | — ½ | *5 7 0 |
| Telegraph Con. | 20 | 20 | 42 | — | *5 13 0 |

*Dividends paid free of income-tax.

## MARKET QUOTATIONS.

It should be remembered, in making use of the figures appearing in the following list, that in some cases the prices are only general, and they may vary according to quantities and other circumstances.

### Wednesday, April 10th.

| CHEMICALS, &c. | | Latest Price. | Fortnight's Inc. or Dec. |
|---|---|---|---|
| a Acid, Oxalic | per lb. | 1/6 | .. |
| a Ammoniac Sal | per ton | £75 | .. |
| a Ammonia, Muriate (large crystal) | " | £73 | .. |
| a Bisulphide of Carbon | " | £38 | .. |
| a Borax | " | £38 | .. |
| a Copper Sulphate | " | £67 10/- | .. |
| a Potash, Chlorate | per lb. | 2/6 | .. |
| a " Perchlorate | " | 2/- | .. |
| a Shellac | per cwt. | £32 10/- | .. |
| a Sulphate of Magnesia | per ton | £15 | £1 dec. |
| a Sulphur, Sublimed Flowers | " | £35 | .. |
| a " Lump | " | £26 | .. |
| a Soda, Chlorate | per lb. | 1/- | .. |
| a " Crystals | per ton | 17½/- | .. |
| a Sodium Bichromate, casks | per lb. | .. | .. |

| METALS, &c. | | | |
|---|---|---|---|
| c Brass (rolled metal 2' to 12' basis) | per lb. | .. | .. |
| c " Tubes (solid drawn) | " | .. | .. |
| c " Wire, basis | " | .. | .. |
| c Copper Tubes (solid drawn) | " | 1/7 to 1/7½ | .. |
| g " Bars (best selected) | per ton | £147 | .. |
| g " Sheet | " | £147 | .. |
| g " Rod | " | £147 | .. |
| d " (Electrolytic) Bars | " | £126 | .. |
| d " Sheets | " | £152 | .. |
| d " Wire Rods | " | £138 | .. |
| d " H.C. Wire | per lb. | 1/3½ | .. |
| f Ebonite Rod | " | 3/- | .. |
| f " Sheet | " | 2/6 | .. |
| n German Silver Wire | " | 2/8 | .. |
| h Gutta-percha, fine | " | 6/10 | .. |
| h India-rubber, Para fine | " | 3/1 | 3d. inc. |
| i Iron Pig (Cleveland warrants) | per ton | Nom. | .. |
| l " Wire, galv. No. 8, P.O. qual. | " | £42 | .. |
| g Lead, English Pig | " | .. | .. |
| g Mercury | per bot. | Nom. | .. |
| e Mica (in original cases) small | per lb. | 6d. to 8/- | .. |
| e " " " medium | " | 8/6 to 6/- | .. |
| e " " " large | " | 7/6 to 14/- & up. | .. |
| d Silicium Bronze Wire | per lb. | 1/6½ | .. |
| r Steel, Magnet, in bars | per ton | .. | .. |
| g Tin, Block (English) | " | .. | .. |
| n " Wire, Nos. 1 to 16 | per lb. | 4/2 | .. |

Quotations supplied by—

a G. Boor & Co.
c Thos. Bolton & Sons, Ltd.
d Frederick Smith & Co.
e F. Wiggins & Sons.
f India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd.
g James & Shakespeare.
h Edward Till & Co.
i Bolling & Lowe.
l Richard Johnson & Nephew, Ltd.
n P. Ormiston & Sons.
r W. F. Dennis & Co.

**Canals Relieving Railways of Traffic.**—Canals are now of greater value to the community, owing to conditions brought about by the war, than they have been at any time since railway transport deprived them of most of their traffic and revenue. The Canal Committee has now under its control 1,202 miles of waterway in England and 304 miles in Ireland. In addition, there are 1,025 miles of canals in England which, as they are owned by railway companies, are managed by the Railway Executive Committee. The financial terms on which the canals were taken over by the Government are the same as those which were allowed to the railways—the guarantee of their net revenue of 1913; but the position of canals and railways is not entirely identical. As the Government scheme of control applies only to the canal companies, it does not guarantee the profits of the canal carriers. It is expected that this drawback will soon be removed, as the Canal Control Committee has made financial recommendations to the Board of Trade for the purpose of enabling the carriers to fix rates that will divert additional traffic to the canals and pay the high wages which labour now demands.

Despite adverse circumstances the Canal Control Committee has already done much to make the canals valuable and economical agencies of transport.—*The Times.*

**Dielectric Tests.**—At the present time there is a notable lack of data on the dielectric constants which pertain to a large variety of substances. A description of a series inductance bridge for measuring dielectric energy losses at low frequencies and high potential gradients is given in the *Electrical World* (Vol. 71, No. 10) by C. A. Butman, which affords a means of obtaining the information. As alternating currents are used, no trouble is caused by the dielectric after-effect, as is the case with direct currents. The bridge gives a means of determining the geometric capacity of condensers having a capacity from 1 mfd. to 0·0001 mfd., with one setting of the bridge arms, with an accuracy of about 0·01 per cent. of the capacity measured. The bridge is especially valuable in investigating anomalous dielectrics. The change of a dielectric to the state of a conductor can be traced by changing the temperature. Moreover, it is now generally recognised that a measure of the dielectric energy loss is the best single test that can be applied to insulation. In designing electrical machinery it is now necessary to take into account, besides the other losses, the dielectric energy loss. This bridge gives a means of determining this loss under the same conditions as obtain in practice.

# THE MECHANICAL DESIGN AND SPECIFICATION OF THE TURBO-ALTERNATOR ROTOR.

By S. F. BARCLAY, Ph.D., B.Sc., A.M.I.E.E.

(*Abstract of paper read before the* Institution of Electrical Engineers.)

(*Concluded from page* 320).

As an alternative to the magnetic and non-magnetic end-bells, there may be considered the question of a composite end-bell. The centrifugal force of the coils varies in the axial direction, being least at the core end and a maximum at the other end. For a 25-in. diameter rotor, for which a manganese-bronze bell could not be used, it would be permissible

Fig. 7.—Composite End-bell for High-speed Rotor.

to employ a composite bell of steel with a relatively narrow band of manganese-bronze next to the core, as shown in fig. 7. The saving in magnetisation loss with such a construction as compared with the all-steel bell may be of the order of 50 per cent. The all-steel nickel-chrome end-bell represents the preferable construction. For a given stress the manganese-bronze stretches (elastically) 47½ per cent. more than steel; for this reason the manganese-bronze ring should be registered on the steel ring, as in fig. 7, and not under it, so that it is free to open. If the bronze were registered under the steel, the projecting lip would prevent the bronze opening sufficiently (elastically) to carry its share of the load, and the lip might be overstressed. The author has heard of failures due to this obvious precaution not being taken.

The usual design of end-bell is a cylinder registering on the rotor core at one end, and on a disk shrunk on to the shaft at the other. In the case of a 5,000-kw., 3,000-r.p.m. alternator the cylinder opens about 0.03 in. in diameter. It is not possible to give the cylinder sufficient initial tension by press fit to prevent it opening in this way. The tendency of the coil loading is to make the cylinder become elliptical, but since there is nothing to centre it definitely it may move bodily out of centre by the amount its opens radially. The vibration with some alternators that cannot be corrected completely is probably due to this cause in some cases. The author is very strongly in favour of making the cylinder and the end disk down to the shaft in a single piece, as shown in fig. 8; the bell is thus definitely centred and eccentricity is prevented. An additional advantage of this design is that it is not necessary to register the bell on the rotor core, and an appreciable gap can be provided between the core and the bell, so reducing the magnetic leakage. The short length of coil between the core and the bell is supported by extending the slot wedge and by registering the end of the wedge under the bell. Another advantage that may be obtained with this construction is to make the seating on the shaft larger in diameter than the slip-rings, so that the end-bells may be removed for examination or repair of the windings without interfering with the slip-rings or the connections to them. The construction also has the advantage of very considerably strengthening the cylinder at the end where it is most heavily loaded.

The various systems of ventilation that have been tried at various times have now settled down roughly to two distinct types—axial and radial. The advantages of the axial system are that the omission of the radial ducts shortens the machine, and that the rotor may be separately and positively ventilated. The disadvantage of this system is that there is an appreciable difference of temperature between the two ends of the machine. The temperature difference may be reduced somewhat by arranging the flow of air through the rotor and stator in opposite directions. With the radial system the temperature rise can be kept almost uniform from end to end, but there are the disadvantages that most useful material is removed from the rotor in forming the radial ducts, and that the rotor ventilation is not positive. The flow of air through the rotor is induced only by the natural fanning effect of the radial ducts, and the flow is opposed by the pressure in the gap set up by the fans. With larger machines the air velocity through the stator has to be made high for the necessary volume of air to flow, and pressure equal to 6 in. or 7 in. of water has to be set up by the fans. At the ends of the rotor such a pressure quite overcomes the rotor fanning effect, and the discharge from the rotor ducts must be prevented, if not actually reversed. It is probably only towards the centre of the core, where the air-gap pressure is reduced, that there is any appreciable flow of air from the rotor.

The author considers the ideal system to be that which has radial ventilation for the stator, with independent axial ventilation for the rotor, as shown in fig. 8. The air for the rotor and stator is kept quite separate, and the volume and temperature rise of it can be separately measured. By varying the rotor fan the volume of air flowing through the rotor can be regulated to give the exact volume required. The omission of the rotor axial ducts gives the designer liberty to work to the tooth density he prefers rather than that to which he may be forced. There must be some difference of temperature between the two ends of the rotor, but the volume of air can be made sufficient to keep the hotter end within the desired limit. By suitably disposing the stator ducts the temperature throughout can be kept substantially uniform. In addition, when necessary, axial ducts may be arranged in the stator, and the discharge from these into the various radial ducts may be separately varied to further equalise the temperature rise. The omission of the radial ducts reduces somewhat the noise of the alternator, and also the windage loss.

It is quite usual to see with an otherwise well-designed rotor, fans that are anything but robust in construction. Sheet steel about 1/16 in. thick for the blades, and about ¼ in. thick or less for the runners, is frequently employed, and apparently that the fans will be satisfactory is taken for granted, and is not verified by calculation. Several cases have come to the author's notice of such fans collapsing and striking the stator end-windings, with complete breakdown of the alternator. Safety must come first, and the permissible number of blades must be determined by the maximum thickness that it is desirable to employ for the runners. The blades should be given such a thickness that collapse is impossible. For the smaller sizes oil-hardened boiler plate is satisfactory for the blades and runners, but for the larger sizes oil-treated nickel-chrome steel plates should be used.

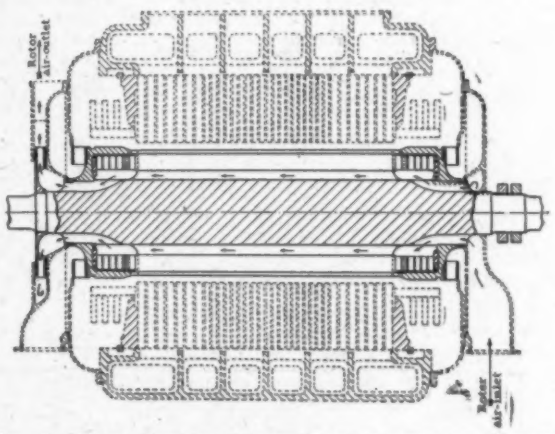


Fig. 8.—Turbo-alternator with Axially-ventilated Rotor and Radially-ventilated Stator.

The loss due to the fans in large high-speed machines is of the order of 20 per cent. of the total windage. The efficiency should be kept as high as possible, since the loss not only affects the alternator efficiency, but also adds to the heating.

With very high peripheral speeds more noise must be expected than with the lower speeds of a few years ago. The station can be made much quieter if the discharge air is led away through a duct, and for large high-speed sets it is very desirable to adopt this arrangement.

Freedom from vibration is an essential mechanical requirement. With marked vibration, wear of rubbing parts may take place at an extraordinary rate, and the soundest construction be weakened in the course of time. A press fit that would be perfectly solid in normal circumstances may become free in the presence of vibration, and relative movement of the parts may take place. Movement of the end windings is more probable, and the insulation under great pressure is very likely to suffer wear. Every component part should be so designed that change of balance is safeguarded against. The degree of balancing should be put on a positive basis by using a vibration indicator. The grooves for the balance weights should be provided in the disk supporting the bell cylinder; the practice of attaching balance weights to the outer fan runners is most unsound. Much time is saved in balancing, and the final result is often better, if the rotor is balanced statically before running. Although the correct division of the balance weights between the two ends of the rotor cannot be determined statically, the total weight required is determined, and adjustment of it only is required when making the running balance. The sensitiveness of the knife edges is much increased by resting the shaft on ball or roller races.

The stresses and pressures for a given rotor increase with the square of the speed. For proving mechanical soundness the overspeed test fails because it is fatigue failure that is most to be feared, and an increase of speed does not prove capacity to withstand fatigue. The overspeed does directly test the soundness of the rotor teeth and of the end-bells, but even its value in this way is limited, because in the event

of there being a flaw, due to the ductile quality of the steel, it is more probable that failure will result after prolonged running than at the moment. A great disadvantage is that the overspeed imposes an undue stress on the insulation that is harmful. The turbine emergency governor should be set to operate at 10 per cent. overspeed, and the set should be capable of standing an overspeed of 20 per cent. At this overspeed the pressure and the centrifugal force are 44 per cent. greater than at the normal speed. The author holds the view that all parts of the rotor should be designed as if it were to run at 20 per cent. overspeed continuously. At the normal speed the stresses and pressures are 30.5 per cent. less, so that the factors of safety in the teeth and end-bells are then very satisfactory.

The author expresses his obligation to Mr. Douglas Vickers and Mr. W. Clark, directors of Messrs. Vickers, Ltd., for permission to read this paper, and his indebtedness to his colleague, Mr. J. P. Nicholson, who conducted the various mechanical tests referred to in the paper.

An appendix gives a specification of a solid forged rotor.

## A LARGE HIGH-SPEED FRANCIS TURBINE.

The accompanying illustration, from an article by Arnold Pfau in *Power*, shows a 25,000-h.p. turbine recently built for the Puget Sound Traction, Light & Power Co. This set is the most powerful high-head Francis turbine in the world, and is practically a duplicate of the two 18,000-h.p. machines already in service at White River, near Sumner, Wash.

The plant has been laid out with a view of maintaining the highest economy of water, since it is combined with a large storage capacity, which furnishes the operating water during dry seasons. The course of the White River is blocked by a timber-crib dam, the water being controlled by steel gates, and led through a heavy timber flume into a forebay. An open canal leads to the storage reservoir, called Lake Tapps, which has a capacity of 2,250,000 cu. ft., equivalent to 18,000,000 kw.-hours, obtained under the net head of 440 ft. From Lake Tapps the water is carried through a deep open cut and a tunnel about 3,000 ft. long, carrying 3,000 cu. ft. of water per second. The tunnel ends in a forebay from which individual 8-ft. steel pipe lines lead down to the power house.

The variation of the commercial load of the Puget Sound traction system is sometimes very severe, and the long tunnel combined with the pipe lines, about 2,500 ft. in length each, together with the requirement of a water-saving method of

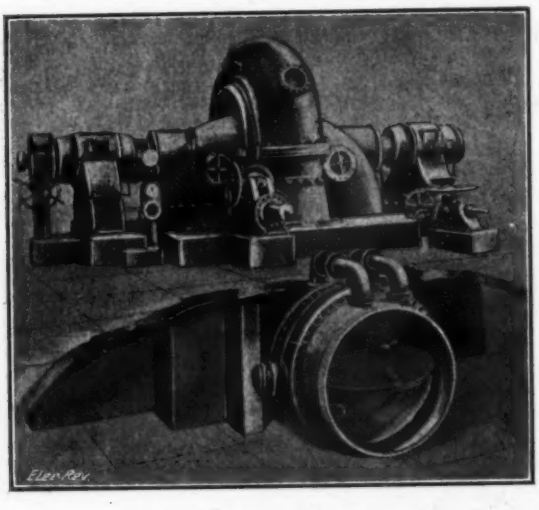

Fig. 1.—25,000-h.p. Francis Turbine.

speed regulation under heavy fluctuations of load over a high-tension transmission line, offered a problem which required careful study.

An analysis of all precautionary methods was made, and as a result it was decided to use:—

1. A surge reservoir at the end of the tunnel to prevent surges affecting the pressure in the pipe lines and *vice versa*.

2. Pressure regulators permitting a sudden release of the water when the governor closes the gates quickly. To prevent waste these by-passes are automatically closed, stopping the flow without causing secondary pressure rises.

3. Air-cushion tanks, to supply hydraulic energy when the demand of load is so sudden that the water cannot accelerate sufficiently fast in the pipe line to prevent a drop in pressure.

The proper combination of these devices, together with a fairly liberal flywheel effect of the generators, enabled a high degree of accuracy in speed regulation to be attained. The turbines of the initial installation are of the double-discharge, horizontal-shaft, spiral-case type operating under a net head of 440 ft. at 360 r.p.m.

The water from the penstock passes through a steel butterfly valve, 7 ft. inside diameter, taking a total normal pressure on the gate of about 1,000,000 lb. The steel runner of the turbine is bolted to a flange forged solid with the shaft, and is of the double-discharge type. The shaft revolves in two ring-oiling bearings with self-aligning ball-and-socket seats, one end having a solid flange for direct coupling to the generator. The opposite end carries the mechanical hand brake, and the bearing at this end serves also as a thrust bearing; the main thrust, however, is automatically taken by means of a simple and efficient hydraulic balancing arrangement, combined with the two runner rims and the adjacent portions of the stationary cover plates. The governor has a capacity of about 50,000 ft.-lb., and is capable of moving the turbine gates over their full stroke in one second.

The turbine discharges about 450 cu. ft. of water per second, and when the flow is stopped through the turbine gates in 1.5 sec., it will discharge through the pressure regulator to its full amount by the time the governor has closed the turbine gates. Thus no serious pressure rises occur due to an abrupt change of velocity in the pipe line.

When the units were put into commercial operation, tests showed an efficiency exceeding 90 per cent., and the efficiency will still be about 80 per cent. at one-fifth load. The full load of 20,000 h.p. was thrown off suddenly, causing the governor to close the gates quickly. The speed did not rise more than 12 per cent. above normal, and the maximum pressure rise in the pipe line above normal did not exceed 5.5 per cent., as against a guaranteed pressure rise of 15 per cent., and a speed rise of 18 per cent.

After five years of continuous service one of these turbines was opened for examination. No repairs whatever were considered necessary, and it was estimated that it would be good for another five years of continuous service under similar conditions.

The results of this examination were so gratifying that it was decided to build the new third unit practically a duplicate of the first two. The rated horse-power was increased from 18,000 to 24,000 without increasing any parts except those directly affected, such as the runner, shafts, guide vanes, &c. It is expected that 25,000 h.p. will be delivered to the generator shaft, and the efficiency and speed regulation will at least be as good as they are with the first sets.

## RAILWAY ELECTRIFICATION AS A MEANS OF SAVING FUEL.*

By E. W. Rice, Jun.

We are in the midst of an extraordinary coal famine. I would like to point out how much worse the situation might have been were it not for the contributions of the electrical engineer; and also how much better our condition might have been if our contributions had been more extensively utilised.

Suppose we assume that the present serious situation is due to a lack of production of coal. It is comforting to consider to what extent the output of our coal mines has been already increased by the use of electrical devices in connection with coal mining, but I think it is a fair assumption that the output of coal mines should have been increased at least 25 per cent. on the average by the employment of such electrical devices. If this estimate were cut down to 10 per cent. it would still leave a possible increase in the tonnage of coal produced of something like 50,000,000 tons during the past year.

If, on the other hand, our situation is due to the failure of the distributive agencies of the country, which is more probable, it is interesting to see how this difficulty would have been largely removed if the railroads of the country had been operated by electricity instead of steam.

Where electricity has been substituted for steam in the operation of railroads, fully 50 per cent. increase in available capacity of existing tracks and other facilities has been demonstrated. This increased capacity has been due largely to the increased reliability and capacity, under all conditions of service, of electric locomotives, thus permitting a speeding up of train schedules by some 25 per cent. under average conditions. In extremely cold weather, when the steam locomotives practically go out of business, the electric locomotives make an even better showing. At a time when the steam locomotive is using up all its energy by radiation from its boiler and engine into the atmosphere, the electric locomotive is operating under its most efficient conditions, and may even work at a greater load than in warm weather.

But this is not all. It is estimated that something like 150,000,000 tons of coal were consumed by the railroads in the

* Abstract of presidential address at the Midwinter Convention of the A.I.E.E., New York City, February 15th, 1918. From the *General Electric Review*.

year 1917. We know from the results obtained from such electrical operation of railroads as we already have in this country that it would be possible to save at least two-thirds of this coal if electric locomotives were substituted for the present steam locomotives. On this basis there would be a saving of over 100,000,000 tons of coal in one year. This is an amount three times as large as the total coal exported from the United States during 1917.

The carrying capacity of steam roads is also seriously restricted by the movement of coal required for haulage of the trains themselves. The useful or revenue-carrying capacity of steam roads could be increased about 10 per cent. with existing track facilities by eliminating the entire company coal movement.

The consumption of oil by the railroads amounted in 1915 to something like 40,000,000 barrels, nearly 15 per cent. of the total oil produced. This fuel is entirely too valuable to be used in a wasteful manner. It is important for many reasons that such a wonderful fuel as oil should be most economically used, if for no other reason than that it will be needed for the ships of our forthcoming merchant marine, for the tractors that till our fields, and the motor trucks that serve as feeders to our railways.

The possible use of water power should also be considered in this connection It is estimated that there is not less than 25,000,000 H.P. of water power available in the United States, and if this were developed and could be used in driving our railroads, each horse-power so used would save at least 6 lb. of coal per H.P.-hour now burned under the boilers of our steam locomotives. Potential water power is being largely lost because most of it is allowed to run to waste, undeveloped, unused. Coal is wasted for exactly the opposite reason; it is being used, but in an extravagant and inefficient manner.

It is really terrifying to realise that 25 per cent. of the total amount of coal which we are digging from the earth each year is burned to operate our railroads under such inefficient conditions that an average of at least 6 lb. of coal is required per H.P.-hour of work performed. The same amount of coal burned in a modern central-power station would produce an equivalent of three times that amount of power in the motors of an electric locomotive, even including all the losses of generation and transmission from the source of power to the locomotive.

It is not too much to say that if the roads of the country were now electrified no breakdown of our coal supply, due to failure of distribution, would exist.

We have had enough experience upon which to base a fairly accurate determination of the stupendous advantages and savings which will surely follow the general electrification of the railroads; in fact, I think we can demonstrate that there is no other way known to us by which the railroad problem facing the country can be as quickly and as cheaply solved as by electrification.

The solution of the railroad problem would also "kill two birds with one stone" by solving the fuel problem at the same time.

We would not be justified in being so confident of the benefits of electrification of railroads if every element in the problem had not been solved in a thoroughly practical manner. There is no element of uncertainty, nothing experimental or problematical, which should cause us to hesitate in pressing our claims upon the attention of the country.

If a general scheme of electrification were decided upon, the natural procedure would be to electrify those portions of the steam railroads which will show the greatest results and give the greatest relief from existing congestion. Electrification of such sections of the steam railroads would have an immediate and beneficial effect upon the entire transportation system of the country.

## ELECTRIC SIGNALLING AND CONTROL ON RAILWAYS.

Mr. Jacob's paper on this subject was discussed at a meeting of the Scottish Local Section of the Institution of Electrical Engineers in Edinburgh.

Mr. C. E. Cockburn (G. & S.W. Rly., Glasgow) spoke of experiments dealing with colour signalling at St. Enoch Street for the purpose of securing something which would convey the same message by night as by day. He admitted the difficulties accompanying the use of orange, and said they had got over the obstacle by adopting a simple device—a bit of cloth stretched on wire guards across a circular disk; this by day showed a bar against the circle, and at night a red bar across a white circle. The system of control through lock and block by track circuit was in operation as far back as the early 'eighties, but had to be taken out owing to the difficulty of maintaining the complete circuit. Other methods had been adopted, and while there were some who thought the introduction of an electric system was going to do everything, the matter was still largely in the experimental stage. He suggested the use of the rails for actuating the control, and while he was told that this was impossible at present, he hoped to see it accomplished.

Mr. Chewan (Edinburgh) agreed with Mr. Jacobs that the high-voltage track circuit would meet requirements, but he thought the initial outlay and maintenance cost would be so great as to prohibit its use. He suggested that instead of working on the present system they should adopt a system by which they could do away with the voltage drop and operate by the current increase in the circuit due to the train shunt coming on to the circuit. That system would be operated much on the lines adopted in the arc-lamp working with shunt and series coils, the idea being that as the current increased in the series coil it would practically neutralise the mechanical effect of the shunt coil, and by doing so drop the relay.

Mr. Donald S. Munro (Edinburgh) questioned whether the time had not come when the whole subject should be discussed on the basis of the complete electrification of the line. When main lines were fully electrical the factors of success and resources of power were wholly changed. In this connection, the devices and experiences of such lines as had already been electrified could usefully be described more fully to the Institution. The methods described by Mr. Jacobs, even with suggested improvement in the proportions of the actuating currents, seemed far too sensitive to be safely dependent upon the very fluctuating resistance of the ballast. That they had had so great a measure of success was much to the credit of the instrument makers and the men who had had charge of their operation. Direct-current devices involved the use of solenoids, make-and-break arrangements with their spring contacts and set screws, and, worst of all, they necessitated small batteries. In addition to these disadvantages, a direct-current circuit always encouraged leakage and corrosion. Reliable main-line signalling apparatus should be standardised in a form applicable to considerable distances, and in a manner guarded from fall of pressure faults, or, on the other hand, from leakage currents from neighbouring power lines. It would seem that the alternating magneto-generator, which had proved so reliable for long-distance telephones, could be applied hopefully to block signalling work. With a magneto-generator in the cabin, and with polarised coils and a rocking armature at the signal post, every rotation of the magneto was positively accompanied by a certain definite series of movements of the rocking armature. These regulated vibrations of the armature might easily be adapted to operate a ratchet escapement. The escapement through a simple mechanical relay could be applied to semaphore posts, lamps, or cab indicators. A few rotations of the armature would release the escapement till the signals stood at "clear." Twice the number of motions would indicate "caution," and thrice would signal "stop." It would not be difficult to arrange a special prolonged emergency stop signal, which could apply the train-lighting battery to a magnetic valve on the vacuum brake. It was admitted that an audible signal in the cabin was desirable, and here the magneto bell would probably work with greater certainty than a D.C. arrangement. In a main-line signal box the separate magneto-generators would be power-operated, with push buttons to control generator revolutions, while a more simple hand arrangement would serve for unimportant lines. The alternating current tended to remove moisture leakage automatically, and this was specially important under exposed railway conditions; then, by fitting condensers, they might confine the effects of possible damage by leakage from a local power circuit. Track-circuiting conditions would change when rails were bonded, and, perhaps, cross-bonded for earth return for electric traction. It might then be necessary to fit a high-resistance contre-rail contact circuit on the first and last pair of wheels of every train, with or without an automatic interruption device, in tune with the relative alarm signal in the cabin and on the locomotive. Even on existing steam lines a track circuit should show when there was no leakage current from rail to rail, *i.e.*, it should indicate a broken circuit.

In a brief reply, on behalf of the author, Mr. Wood said the question of train control must be looked at from common lines, and he had no doubt that some universal system would yet be decided upon. The introduction of the magneto in place of so many primary batteries would mean much scrapping of existing apparatus, and it was somewhat questionable if a failure could be so easily secured on the side of safety.

## COAL AND PEAT SUPPLIES FOR POWER.

The Dublin Local Section of the Institution of Electrical Engineers recently considered the report of the Coal Conservation Sub-Committee on Electric Power Supply in so far as it affects Ireland.

Major O. T. O'K. Webber, R.E., who presided, said the solution of the workman's problem and that of the employer lay in the greatest possible use of power, hence the growing importance of having available an adequate and cheap supply of power produced with the greatest economy of fuel. Seaborne coal was not to be despised, as it could be landed direct into the power station at the water's edge. As to native coal in Ireland—his own experience only extended to the Leinster coal—it could only be called a somewhat refractory fuel, as it was deficient in by-products, and an adequate supply for the necessary size of station was unattainable. The super-power station held out great hopes as a means of realising the great wealth of the Irish peat deposits.

Mr. G. Marshall Harriss, manager of the Dublin United (Electric) Tramways, referred to the question of cheap power as of vast national importance; the only way in which they could keep up wages in Ireland was to increase their industries, and the only way in which they could do that was through cheap power. Great Britain would have the advantages of super-power stations to conserve its coal supply, and unless they in Ireland took steps in the same direction, no legislation that could be devised would stop their best young men from leaving the country to go where they would be better paid. It was doubtful if the Irish coal seams were big enough, or if coal could be raised in competition with England, even plus the cost of carriage across. For such a scheme as would put Ireland on a sure footing they should be assured of a supply for 100 years. He did not think their water-power was sufficient; but peat was there, and they should use every means at their command, and spare no money to see that that great resource was developed. He believed it was possible, with proper machinery, to provide peat which would be nearly as good and as cheap as coal.

Mr. Thos. Tomlinson said they had 3,000,000 acres of peat right across the centre of Ireland, which would be equal to about 3,200,000,000 tons of coal; while using this they would be uncovering 5,400 acres of first-class limestone marl. By reducing the moisture of peat by 10 per cent., a ton of peat would be nearly equal to a ton of coal.

Mr. Wm. Tatlow advocated the use of water-power for the sake of economy.

Mr. J. P. Tierney said that one of the difficulties about the utilisation of peat for power purposes was the cost of acquiring the right to work the peat deposits. In this matter they could learn from Belgium, where the State took over the bog and fixed the price of it, advancing capital at 2 per cent. to public companies, and the Government appointed a certain number of directors on the company boards. On the question of water-power, he said that what had been done in the utilisation of the water of the Mississippi for St. Louis, 150 miles away, showed that the suggested scheme for the Highlands of Donegal might possibly be worked as a complement to the Central Ireland scheme for the utilisation of peat.

Mr. J. J. Parkinson, of the Wolfhill Colliery, deprecated adverse criticism of the Irish coal deposits. The Leinster coalfield constituted 75,000 acres. At the Castlecorner end there was a 4-ft. seam extending over 5,000 or 6,000 acres, and there was a 2-ft. seam practically all over the rest of the field. He estimated that there were 150,000,000 tons of coal in the Leinster coalfield. They were now putting down plant to produce 1,000 tons a day of anthracite coal, which would probably be equal in value to 3,000 tons of bituminous coal.

Mr. L. J. Kettle, Dublin Corporation electricity department, entered a protest against the Coal Conservation Committee's suggestion that the electrical schemes should be put into the hands of private companies, and not entrusted to the management of the State or local authorities. The exceptionally-situated North of England scheme alluded to by the Committee was cheaply worked on account of its utilisation of waste heat from blast furnaces, &c. There would be great difficulty in carrying out the recommendations of the Committee in England because of the diversity of design of the various plants already in existence there. Ireland had so far very few electricity schemes, and very little industrial development. It was, in fact, a virgin country. In his opinion, it would be much easier to carry out a comprehensive scheme with a large central-power station and smaller stations on a standard plan in Ireland than in any of the highly industrialised countries; but before anything could be done, there should be a national survey of the power resources of the country, and that, he submitted, was not the business of any private individual or private company, but the business of the State as a whole. It was little credit to the responsible Government in Ireland that they had not got a single item of information in this respect to go upon. He concurred with Mr. Parkinson as to the excellence of the Wolfhill coal; the only thing was that, unfortunately, they could not get enough of it.

## NEW PATENTS APPLIED FOR, 1918.

(NOT YET PUBLISHED.)

Compiled expressly for this journal by Messrs. W. P. Thompson & Co., Electrical Patent Agents, 285, High Holborn, London, W.C., and at Liverpool and Bradford.

5,191. "Ignition devices for internal-combustion engines." W. G. Ikin. March 25th

5,202. "Telephone receivers, &c." J. W. Horley. March 25th.

5,208. "Electric ignition device." H. E. Partridge. March 25th.

5,216. "Electromotors." W. E. Clifton. March 25th.

5,230. "Electric couplings." H. de la Valette. March 25th. (France, March 28th, 1917.)

5,241. "Electric transformers." J. L. Thompson, and British Westinghouse Electric & Manufacturing Co. March 25th.

5,245. "Electric heating devices for hatching, bacteriological, &c., apparatus." Sir C. S. Forbes. March 25th.

5,265. "Electrical switchboards." T. Manson. March 26th.

5,286. "Electric motors." W. F. Higgs. March 26th.

5,314. "Systems of electrical distribution." A. Crooke & T. Thompson. March 26th.

5,322. "Circuit breakers." Igranic Electric Co. (Cutler-Hammer Manufacturing Co., U.S.A.) March 26th.

5,323. "Lampholders for incandescent electric lamps." C. L. D. Delanne. March 26th. (France, March 19th, 1917.)

5,329. "Electrical heating apparatus." C. Sorensen. March 26th.

5,342. "Apparatus for electrically treating soil for agricultural purposes, &c." F. H. Hall. March 27th.

5,353. "Method of carrying and springing accumulators on motor cycles and motors cars." R. Gamblin. March 27th.

5,354. "Electric ladle." E. Lewis. March 27th.

5,381. "Automatic telephone systems." Automatic Electric Co. & Automatic Telephone Manufacturing Co. March 27th.

5,395. "Electric arc lamps." H. B. Grylls & W. Heape. March 27th.

5,404. "Means for obtaining high-tension direct-current voltages." F. E. Berry. March 27th.

5,410. "Method of producing showers, &c., of electric sparks for advertisement purposes." O. Tange. March 27th.

5,420. "Auto-generating portable electric lamp." V. Filippone. March 27th.

5,421. "Interlocking mechanism for electric switches, &c." C. J. Baker and V. G. Middleton. March 27th.

5,423. "Searchlights, &c." E. A. Sperry. March 27th. (U.S.A., March 27th, 1917.)

5,476. "Telephone systems." Automatic Telephone Manufacturing Co., A. J. Ray & J. Savin. March 28th.

5,477. "Telephone systems." Automatic Telephone Manufacturing Co., A. J. Ray & J. Savin. March 28th.

5,478. "Telephone systems." Automatic Telephone Manufacturing Co. and A. J. Ray. March 28th.

5,479. "Apparatus for electrolysing salt solution." T. Matsushima. March 28th. (Japan, March 30th, 1917.)

5,504. "Means for cleansing sparking plugs of internal-combustion engines, &c." G. J. Scott. March 28th.

5,560. "Switches." H. Lucas & W. C. Turner. March 30th.

5,561. "Ignition apparatus for internal-combustion engines." H. Lucas. March 30th.

## PUBLISHED SPECIFICATIONS.

The numbers in parentheses are those under which the specifications will be printed and abridged and all subsequent proceedings will be taken.

### 1917.

264. System and Means for Electric Ignition of Gas, Petrol, and like Internal-combustion Engines. W. S. Frost. January 5th, 1917. (113,799.)

1,082. Variable-speed Generators and Storage Battery Systems. H. A. Gill (U.S. Light & Heat Corporation). December 5th, 1916. (Divided application on 17,452/16.) (113,258.)

1,729. System of and Apparatus for Wiring Ships, Buildings, and the like for the Distribution of Electricity. L. M. Waterhouse. February 3rd, 1917. (113,800.)

1,763. Electric Contact-making Device especially adapted for use in Ignition Systems. J. Y. Johnson (N. Mellor). February 3rd, 1917. (113,802.)

3,113. Manufacture of Carbon for Electrochemical, Metallurgical, and other Services. T. W. S. Hutchines. March 2nd, 1917. (113,812.)

3,318. Control and Regulation of Electric Furnaces. Brown, Boveri and Co. & A. Gray. March 6th, 1917. (113,827.)

3,422. Method of and Apparatus for Welding or Sintering Tungsten Ingots and the like. M. J. Insull. March 8th, 1917. (113,835.)

3,425. Electrical Contacts. M. J. Insull. March 8th, 1917. (113,838.)

3,426. Electric Furnaces. M. J. Insull. March 8th, 1917. (113,839.)

3,748. Overhead Equipment of Electric Tramways. J. Duggan. March 15th, 1917. (113,850.)

3,874. Tubular Demountable Resistance Units for Rheostats. Igranic Electric Co. (Cutler-Hammer Manufacturing Co., U.S.A.) March 16th, 1917. (113,854.)

4,116. Means for Coupling a Magneto-generator with an Internal-combustion Engine. D. Y. Wheatley. March 21st, 1917. (113,859.)

4,556. Engine Starter. V. Bendix. March 26th, 1917. (113,527.)

4,580. Windings for Electric Transformers and similar apparatus. British Thomson-Houston Co. (General Electric Co., U.S.A.) March 29th, 1917. (113,356.)

4,720. Automatic Device for Wireless Signalling. J. Morrison & W. A. Morrison. April 24th, 1917. (113,532.)

5,151. Electric Welding Apparatus. W. H. Isherwood & W. H. Turner. April 12th, 1917. (113,537.)

5,305. Insulating Devices for the Live Rails of Electric Railways. W. E. Windsor-Richards & E. T. Brooks. April 14th, 1917. (113,362.)

6,437. Micro-telephones for use in Automatic Exchange Systems. H. Symes. June 26th, 1916. (108,463.)

6,298. Sparking Plugs. T. E. Ponset. June 26th, 1916. (108,461.)

6,699. Lead-covered Cables. British Insulated & Helsby Cables, Ltd., and R. W. Blades. May 11th, 1917. (113,378.)

6,700. Lead-covered Cables. British Insulated & Helsby Cables, Ltd., and R. W. Blades. May 11th, 1917. (113,379.)

6,725. Protection of Electric Distribution Systems. P. V. Hunter, J. R. Beard & Electrical Improvements, Ltd. May 11th, 1917. (113,380.)

7,842. Method and Means for Electrically Welding and Shaping the Rims of Wheel Tires. R. Kronenberg. May 23rd, 1917. (113,882.)

7,820. Miners' Safety Lamps. R. Lambourne. May 31st, 1917. (113,386.)

8,814. Means for Adjusting Electric and Gas Lamps. G. E. Etlinger. June 19th, 1917. (113,391.)

9,014. Electric Transformers, especially suitable for use in connection with Electric Furnaces. J. Bibby. June 22nd, 1917. (113,899.)

9,404. Interrupting Devices for the Electric Ignition of Internal-combustion Engines. O. Imray (R. Bosch). June 29th, 1917. (113,230.)

9,496. Trolley Heads of Electric Tramcars and the like. A. Harwood and F. H. Bennett. July 3rd, 1917. (113,901.)

9,784. Telephones. E. A. Petithory. July 6th, 1917. (113,565.)

10,052. Electric Switch. W. S. Shephard. July 12th, 1917. (113,905.)

10,242. Rotary Electric Switches. A. A. Buck. July 16th, 1917. (113,400.)

10,379. Method of and Arrangements for Extracting Zinc by the Electro-thermal Process. E. S. Berglund. September 5th, 1916. (109,435.)

10,636. Condensers for Ignition Magnetos. E. A. Watson & M-L Magneto Syndicate. July 24th, 1917. (113,910.)

10,832. Telephone Transmitter. W. Birrell, J. Birrell & R. A. Cavenaugh. July 27th, 1917. (113,912.)

11,357. Magnetic Blocks for Holding Pieces of Iron or Steel during Grinding, Planing, and the like Operations. G. Khisanachoill. August 7th, 1917. (113,568.)

12,290. Apparatus for Ignition in Explosion Engines. J. H. Stringham. August 27th, 1917. (113,231.)

12,734. Electro-pneumatic Braking Systems. W. V. Turner. March 29th, 1917. (113,235.)